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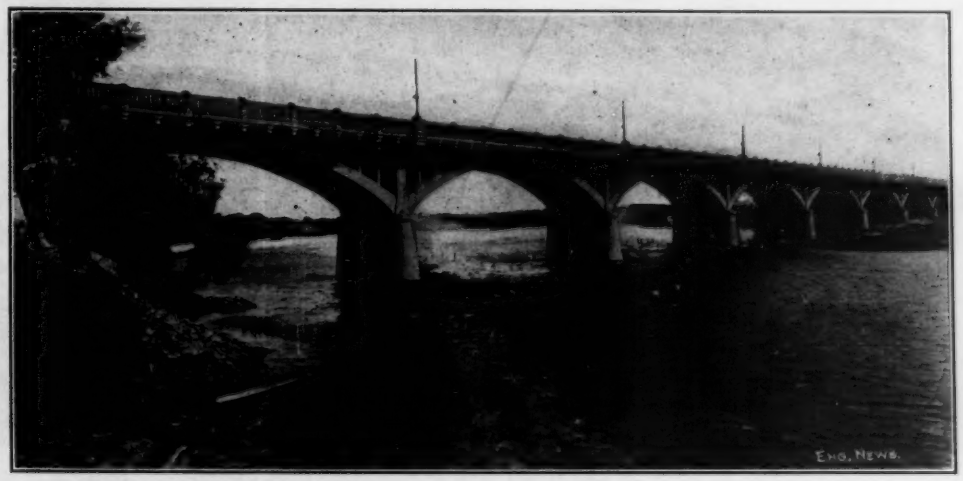
## A New Reinforced-Concrete Bridge Across the Colorado River, Austin, Texas.

The bridge shown by the half-tone view herewith presents a satisfying combination of structural simplicity and pleasing effect. That bridges of this kind are becoming steadily more common, and bridges of clumsy appearance correspondingly more rare, is good evidence of the progress made in the art of designing reinforced-concrete arch bridges. The well-emphasized arch ring and the overhanging floor with its neat capping rail contrast in due proportion with the piers and the spandrel supports. Apparently no architectural assistance was required for planning the structure, and the result is to be credited wholly to the good taste of bridge engineers.

The bridge crosses the Colorado River (of Texas) at Austin, Tex., and was completed only recently. It is 1,000 ft. long, consisting of eight barrel arches, each of 115-ft. span, and with 18-ft. rise. The arch ribs are 32 ft. wide and support 15 reinforced vertical members, which, united by arches, carry the floor system. The entire floor system is 50 ft. wide, 38 ft. of which is taken up by the roadway and the remainder by sidewalks. The additional width of 9 ft. on each side, forming the sidewalks and part of the roadway, is secured by the use of cantilever arms. The handrails are of concrete in ornamental design. The roadway is paved with creosoted blocks.




A REINFORCED-CONCRETE BRIDGE ACROSS THE COLORADO RIVER, AUSTIN, TEXAS.

The bridge cost $200,000 or about $4 per surface sq. ft.

The engineers for the structure were Waddell & Harrington, of Kansas City, Mo., with Mr. C. K. Allen, resident engineer. The William P. Carmichael Co., of Williamsport, Ind., and St. Louis, Mo., was the contractor, the construction work being done under the direction of Mr. H. M. Cryder, Manager, and Mr. C. J. Grove, Superintendent.

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**THE INSTALLATION OF ELECTRICAL EQUIPMENT** for operating the big gates of the Laguna Dam is progressing. This dam forms an essential part of the Yuma Irrigation Project of the United States Reclamation Service, and was described in our issues of Feb. 27, 1908, and June 10, 1909; specifications for dam Feb. 9, 1905.

## The Construction of the Cataract Dam, Sydney, N. S. W. *

By L. A. B. WADE,† M. Inst. C. E.

Sydney, the metropolis of New South Wales, is supplied with water from a catchment-area of 354 square miles, mostly Crown lands. The supply is conveyed from the catchment a distance of 40 miles by tunnel and canal to the Prospect storage-reservoir of 11,500 million imp. gal. capacity, only 6,000 millions of which can be drawn off by gravitation. These tunnels and canals have a capacity of only 150 million imp. gals. per diem, and consequently large volumes of water were running to waste when the flow from the catchment-area exceeded that amount. A succession of dry years demonstrated that the dry-weather flow from the catchment, supplemented by the volume available by gravitation from the Prospect reservoir was insufficient for the increasing requirements of the metropolis; and further, that portions of the earth embankment across the valley forming that reservoir were in an unstable condition when water was drawn below certain levels. It was therefore deemed advisable to augment the supply to Sydney by constructing storage-reservoirs on the catchment-area itself, the capacity of the tunnels and canals being more than sufficient for the daily requirements of many times the present population. An examination was made for suitable sites, with the result that six were located on different branch streams. The first selected for construction is situated on the Cataract River, having a catchment-area above it of 53 square miles. The geological formation of the Cataract catchment consists of Hawkesbury sandstone overlying coal-measures, and the area is bounded on its upper end by a range of high hills rising abruptly a short distance back from the ocean. Coal-seams outcrop on the side of the hills facing the ocean and dip with a fairly rapid inclination underneath the Cataract catchment. The seams have been worked from the face of the hills for some years, and coal-mining operations now extend under and past the divide. These operations, although so far well under the catchment-area, have not extended underneath that portion which will be covered by the stored water; when this does occur the minimum cover between the stored water and the coal-seams at the upper end of the storage will be 800 ft., increasing to 1,600 ft. at the dam site. The Water and Sewage Board, to whom all works are handed over by the Public Works Department on completion, suggested to the Department of Mines the advisability of reserving from coal-mining operations all Crown land within the whole Sydney catchment-area that would be enclosed by boundary lines ¼-mile outside of and parallel to the edge of the stored water at each proposed reservoir. In accordance with a joint report made by Mr. E. J. Pittman, Government Geologist, and Mr. A. A. Atkinson, Chief Inspector of Coal and Shale Mines, however, the Government considered that there was not sufficient reason to prohibit mining under the site.

This report is in part as follows:

> The area of the reservoir, when full, will be approximately 2,518 acres, and if to this be added the ¼-mile barrier previously referred to, we arrive at a total of 9,065 acres. Assuming that only one workable coal seam, 5 ft. in thickness, underlies this site, the value of the coal (at 9s. per ton) under the area first mentioned (2,518 acres) would be £5,665,500 and royalty payable to Government (reckoned at 6d. per ton for round coal and 3d. per ton for small) would amount to £314,750. The value of the coal under the larger area (9,065 acres) would be £20,396,250, and the royalty payable thereon would amount to £1,133,125.
>
> It is understood that the Water and Sewage Board have gone so far as to question the advisability of allowing the coal to be worked under any portion of the reserve for the water-supply of Sydney. This reserve has an area of 354 square miles, and on the assumption that it is underlain by only one workable seam, of a thickness of 5 ft., the ultimate value of the coal would be about £509,760,000 and the royalty payable thereon would amount to £28,320,000.
>
> These figures are necessarily only approximations, but they are quite as likely to fall short of as they are to exceed the truth, and their magnitude will give an impression of the vast importance of the interests involved in this question. The water supply of Sydney would surely be a very costly one if its maintenance entailed the locking up of mineral of a value approaching £500,000,000 sterling; and if it could be shown that the extraction of the coal would seriously affect the catchment-area it appears to us that it would be a fair subject for the consideration of the Government as to whether it would not be preferable to seek for another source of water supply rather than sacrifice mineral resources whose prospective value exceeds sixfold the national debt of the State.
>
> We believe, however, that there will be no necessity to consider this alternative, for we are strongly of opinion that the coal can be extracted without detriment to the surface of the catchment-area, and without affecting the holding capacity of the reservoir.

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*From a paper entitled "Concrete and Masonry Dam Construction in New South Wales," presented to the Institution of Civil Engineers. This dam was the subject of articles in Engineering News, Dec. 6, 1906, p. 579, and Dec. 3, 1908, p. 606. In neither of these articles was there any very complete description of the work but both were illustrated with fine views of the dam during construction.

†Chief Engineer, Rivers, Water-Supply and Drainage Branch, Public Works Department, New South Wales, Sydney, N. S. W.

The cover over the Bulli seam is composed of what is known as the Hawkesbury series, consisting of considerable thicknesses of tuffaceous shales and massive beds of sandstone. The experience gained in the working of coal seams in other parts of the world convinces us that with this thickness of shale and sandstone intervening between the coal seam and the floor of the reservoir, the working of the coal can be accomplished without any danger of injury to or undue leakage from the reservoir. For while a slight subsidence of the surface may occur when the coal is entirely removed, there is no reason whatever to fear that this would be accompanied by any such leakage as would interfere with the water supply.

With a view of guarding against the slightest possibility of damage to the stability of the retaining wall of the Cataract Dam through subsidence, a solid pillar of coal should, we think, be left beneath it, and this should be of such dimensions as to extend for a distance of 300 yds. beyond the base of the wall in all directions.

If these precautions be observed, we feel convinced that the valuable stores of coal under the reserve can be extracted without any danger to the water supply of Sydney.

The dam built across the Cataract River as a first instalment of the additional storage-works for the metropolis is straight in plan and, when the reservoir is full, will retain 21,411 million imp. gallons of water, covering an area of 2,400 acres. The accompanying figures illustrate the leading features of the dam, and the principal dimensions are:

| | Ft. |
|---|---|
| Length of wall | 811 |
| Height above river-bed | 157 |
| Depth below river-bed | 35 |
| Maximum total height from base to top | 192 |
| Top width | 16½ |
| Bottom width | 158 |
| Maximum depth of water stored | 150 |
| Length of spillway weir | 715 |

All flood-waters are passed over the weir, which has a spillway leading into a gully that joins the river about 200 yards. down-stream of the wall. The greatest estimated flood when at its maximum would be equal in volume to a depth of 4 ft. 6 ins. passing over this weir. The top of the dam-wall is 7 ft. above the crest of the weir, leaving a freeboard of 2 ft. 6 ins. for wave-action. No account has been taken of the effect on floods of storage above the level of the weir-crest.

MATERIALS AND CONSTRUCTION.—The only material available in bulk on the site, for use in constructing the dam, was local sandstone of the Hawkesbury series. The author was of opinion, from the results of experiments made and of observations on the site, that this sandstone was suitable for use in large blocks if carefully quarried from selected layers and disposed in the work so as to be free from the influences of weathering. In breaking to a gage for concrete, however, it was found that the best of these sandstones became very shaken, so much so that a clause prohibiting their use for concrete was subsequently inserted in the specification.

The Hawkesbury sandstones are intersected by numerous basaltic dikes, which are in the majority of cases so decomposed as to be unfit for use as concrete, but in all cases the sandstone walls enclosing them are more or less vitrified by the heat of the basalt flow, and afford in limited quantities an excellent material for such a purpose. In designing the wall it was assumed that it would be built of large blocks of the local Hawkesbury sandstone surrounded with basalt or altered-sandstone concrete, the average weight being taken at 140 lbs. per cu. ft.

Up to that date no structure of the magnitude and nature of the dam proposed had been built in the State using a sedimentary rock of the nature of Hawkesbury sandstone. This material was well known to expand and contract in a very marked degree with absorption or loss of moisture. A sample block of sandstone, therefore, 20 × 2 × 2 ft., was cut in one of the quarries during the construction of the works; this was placed on free rollers, protected from the weather, and tested for contraction and expansion. The maximum contraction between the green condition as taken from the quarry and a thoroughly dried-out condition amounted to 3/16-in.; the maximum expansion from the dried-out condition to a condition when the stone was thoroughly saturated with water was 7/32-in. The observations were taken at similar temperatures, it being considered that in a dam of such thickness the effects of variations of temperature might be neglected.

It was considered advisable, when preparing the design, to make a liberal allowance in the cross-section, on account of the unknown internal strains that might be set up in the wall by the unequal absorption and distribution of moisture from the stored water; with this in view the maximum crushing stress to which the material would be subjected was limited to 8½ long tons (9½ short tons)* per sq. ft. It has been sought, by the insertion of drains, to keep the moisture retained within the wall as evenly distributed and as nearly constant in amount as possible, and thus to reduce the liability of unequal internal stress occurring. These drains consist of a system of 6-in. rectangular conduits filled with broken stone, placed parallel to and situated about 6 ft. back from the up-stream face of the wall: they are collected into 6-in. diameter earthenware pipes laid at right-angles to the longitudinal axis of the wall, with exits on the down-stream face. Special precautions, which will be described later, were also taken to reduce the permeability of the up-stream face of the wall.

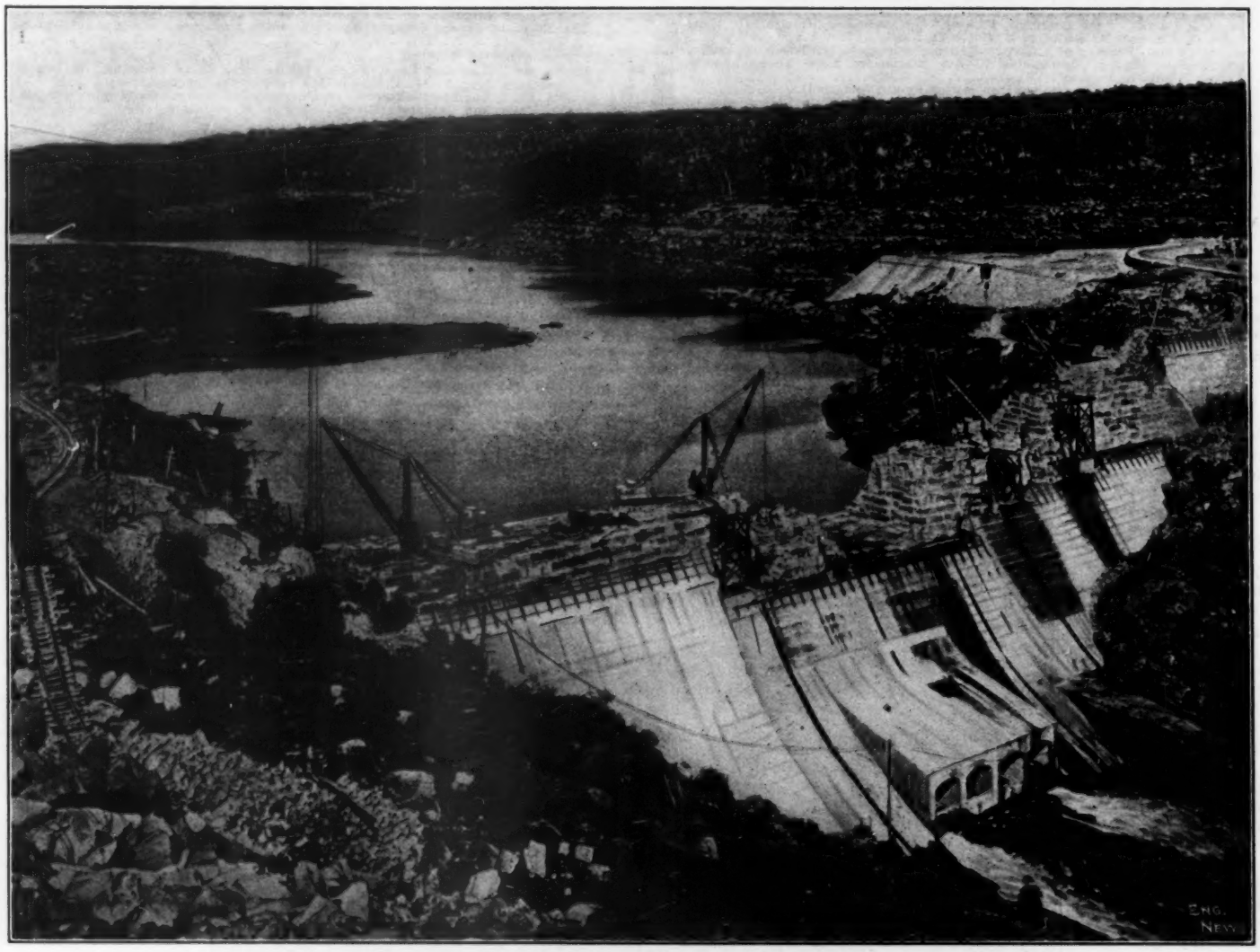


FIG. 1. VIEW OF CATARACT DAM DURING CONSTRUCTION.

The results of testing a number of 12-in. cubes of sandstone taken from the quarries during construction and crushed unsupported in a testing-machine gave an average strength of 276.3 long tons per sq. ft. (4,300 lbs. per sq. in.). Concrete and mortar used in the work were also subjected to tests in a similar manner, with the following average results 90 days after making:

| | |
|---|---|
| No. 1 concrete | 1,810 lbs. per sq. in. |
| No. 3 concrete | 1,720 lbs. per sq. in. |
| Mortar for bearing | 1,600 lbs. per sq. in. |

The sandstones upon which the wall is founded are bedded horizontally in layers ranging from 2 to 15 ft. in thickness, the layers consist of a coarse-grained hard and a finer-grained soft stone, the coarser stone being the more pervious to water under pressure. The beds between the layers where they have not been exposed to the air are close and watertight. The only excavation necessary under the flanks of the wall was for the removal of rock where the beds and joints had been affected by weathering; otherwise, beyond surface decomposition, the rock itself was sound. In one case a block of about 250 cu. yds., which had moved slightly on a weathered bed, was deemed unsafe and was removed. A large water-hole existed in the bottom of the gorge to the full width of the wall, the water in which, being charged with acids liberated from accumulations of de-

*Long ton = 2,240 lbs. Short ton = 2,000 lbs.

cayed eucalyptus vegetation, had penetrated and affected the joints of the rock for a considerable distance. The layers of sandstone under the bottom of the water-hole differed slightly from those at the higher levels, being intersected by a false bedding which varied in inclination and direction. The rock under the water-hole, owing to its stratification and to the agencies acting upon it, was consequently loose and open-jointed for a depth of 35 ft., when an extremely hard horizontally-bedded layer was met with. A shaft and a series of drill-holes were sunk through the layer across the width of this part of the foundations to a depth of 15 ft. Several of the holes tapped springs which were brought to the surface through pipes, and, after flowing freely for some time, drained, and were subsequently unaffected by the levels of the stored water behind the wall. A few small springs met with in other parts of the foundations were treated in the same way and the same results were obtained, showing that they were fed from an accumulation of water supplied probably from the hillside. A thin layer of a soft, coarse, sandy nature between two hard layers of sandstone, and situated under the right flank, was cut out by a drive measuring 5 × 3 ft. and about 50 ft. in length; this was filled with concrete and pressure-grouted on top through drill-holes.

The bedding of the sandstones necessitated the excavation of the foundations under the flanks of the wall being taken out in a series of rectangular steps. A vertical key was in all cases excavated in the sides of the steps, a short distance back from the face of the wall.

It was anticipated when the dam was projected that there would be leakage under the flanks of the wall through the coarser layers of sandstone, though no real loss of water would result from such leakage as it would be diverted from the river lower down and conveyed by the tunnels and canals to Prospect. With the present head of water retained—107 ft.—this leakage is much less than anticipated, having only developed to a small extent through one coarse layer of rock about 2 ft. in thickness.

In determining the composition of the wall, regard was had to the relative quantities of the different materials available, which were then disposed as follows: The body of the dam was constructed of cyclopean rubble masonry consisting of roughly rectangular blocks of sandstone weighing 2 to 4½ tons, built to break joint vertically and horizontally and to have a maximum of bond. The stones were bedded in cement mortar and the vertical joints were made with basalt and altered-sandstone concrete. The up-stream face consists of basalt-concrete blocks 5 × 2 × 2 ft. 6 ins., set with special cement mortar and backed with concrete. The down-stream face is of basalt concrete, 6 ft. thick in the lower and 3 ft. thick in the upper levels. Reinforced concrete was used in the construction of the valve-hoods and penstock-chambers.

The following specified classes of concrete were used in the work:

No. 1 concrete, for use in the up-stream face-blocks, the lining of off-take vertical shafts, and all surfaces exposed to the water: Cement, 375 lbs. (about 4½ cu. ft.); sand, 7½ cu. ft.; bluestone and shivers, 15 cu. ft. (a 1:1.7:3:4 mixture); the bluestone and shivers being in ratio of 3 parts of 2½-in. stone to 2 parts of ¾-in. shivers.

No. 2 concrete, for use on the outside of the 4-ft. off-take pipes, the tunnel and the lower valve-chamber and for filling cut-off trenches: Cement, 375 lbs.; sand, 10 cu. ft.; bluestone and shivers, 20 cu. ft. (a 1:2:5 mixture).

No. 3 concrete, for use in the down-stream face of the dam, in the hearting work where voids were large enough, for filling the shaft, and between the back of the blocks and the facing-boards: Cement, 375 lbs.; sand, 11½ cu. ft.; and 3-in. bluestone, 20 cu. ft. (a 1:2½:5 mixture). Approved sandstone metal was accepted under certain conditions in lieu of the bluestone.

The cement used was manufactured locally and supplied by the Government to the contractor without payment.

The sand was crushed from sandstone quarried out of a soft saddle in the vicinity, and broken by a rotary crusher. This machine reduced the bulk of the material to sand, and the residue which would not pass through the screens was finally dealt with by rolls. The crushed material was washed by a stream of water in a flume and cast out by hand-labor. The resulting sand was of excellent quality, sharp, and with a gradual gradation from coarse to fine.

Basalt for Nos. 1, 2 and 3 concretes was quarried from a dike about 6½ miles away, broken in a crusher and then conveyed on a 2-ft. gage railroad to the site of the dam.

The bulk of the sandstone which was accepted for No. 3 concrete in place of bluestone was quarried from the walls of the dike from which the basalt was obtained. It was broken and conveyed to the site by the same means, and a smaller quantity was also obtained from the walls of a decomposed basalt dike situated about 2½ miles away. The sandstone blocks forming the cyclopean rubble masonry were quarried from selected layers in the spillway quarry and a quarry at the opposite end of the wall. The face of the quarry was broken down by

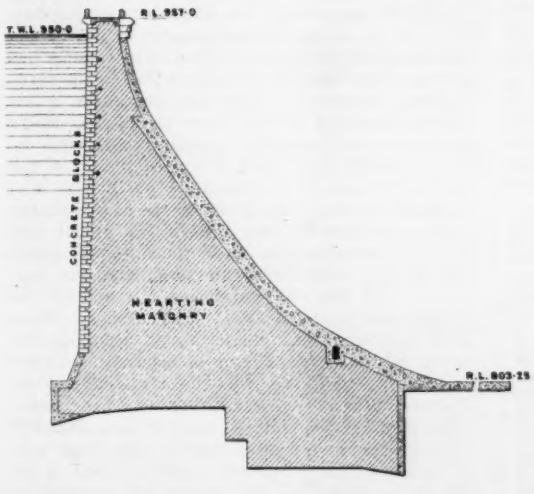



Fig. 2. Plan and Section Through the Cataract Dam; Water-Supply of Sydney, N. S. W.

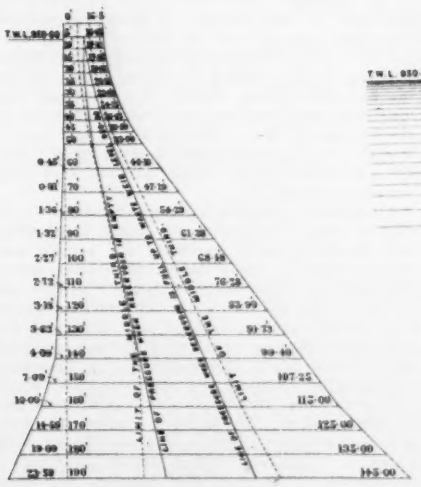



Fig. 3. Typical Section of the Cataract Dam.

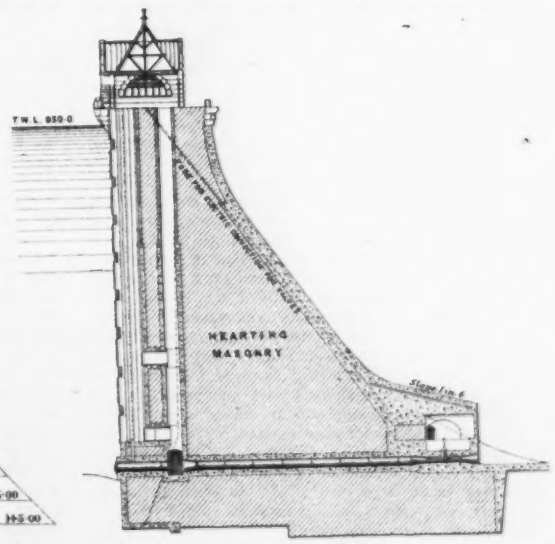



Fig. 4. Section through Outlet Chambers of Cataract Dam.

blasting in large masses; the stones were then cut from the selected layers by means of wedges, and required a very small amount of additional work to meet the requirements of the specification. About 50% of the sandstone material quarried was run to spoil as unsuitable for use in the wall.

The methods adopted in the construction of the body of the wall were the following. The hearting masonry was measured in its completed bulk, and no account was taken of the relative quantities of sandstone blocks, cement mortar and No. 3 concrete of which it was composed. The contractor was allowed to vary the relative quantities of stone, mortar and concrete, making up the hearting masonry by putting more or less work on to the sandstone blocks of which it was chiefly composed, provided always that the sandstone blocks formed not less than 70% of the total bulk of the hearting masonry. Should the contractor put in a less proportion of sandstone blocks than the 70% specified, the engineer had power to value the additional cement used, and to deduct such value from any money due, or becoming due, in respect of the contract. It was found during construction, however, that the ratio 65 to 35, of sandstone blocks to concrete and mortar, represented better work in securing bond and packing than the 70% of blocks specified, and the specification was deviated from to that extent.

The whole of the hearting between the up-stream and down-stream facework was composed of masonry built of sandstone blocks of as large a size as practicable, and hewn to a roughly rectangular form, no stone being less than 2 ft. in depth, or with a less cubical capacity than 20 ft. when measured on its smallest dimensions. The bulk of the stones were used green as they came from the quarry and were thoroughly wetted before laying. No horizontal courses were permitted. Vertical joints between adjacent stones, which were large enough and in such a position as to admit of concrete being thoroughly rammed therein, were filled with No. 3 concrete, all other joints being thoroughly filled with cement mortar. In cases where it was necessary to make up a bed No. 3 concrete was used, or the contractor was allowed, with the approval of the superintending officer, to build in selected hand-stones, laid in cement mortar. The use of cement mortar in beds, joints or filling where No. 3 concrete or sandstone rubble could be used was not allowed, nor was the use allowed of sandstone blocks so roughly hewn as to cause the mortar and concrete used in the hearting masonry to exceed the specified proportions.

No difficulty was experienced in securing good bedding of the large blocks: a system of wriggling the stones on the mortar beds with bars expelled all air and gave much better results than ramming. Of the many stones lifted after being set, all were found to be free from air-spaces in their beds.

The concrete blocks for the up-stream faces of the dam were cast in wooden boxes. The corners of the exposed face were made with a flat chamfer, which chipped rather in handling, and a rounded chamfer is recommended for future work. The blocks were composed of No. 1 basalt concrete with a maximum of 25% of basalt hand-stones, and with the neat cement worked to a skin on all sides, were practically impervious to water under pressure. The success attained in the efforts to make the wall impermeable, as demonstrated by the small quantity of water issuing from the drainage-pipes and by the dryness of the down-stream face of the wall under the greatest head experienced, is due in the opinion of the author largely to the use of the concrete blocks; these, in addition to their impermeability, presented true vertical back faces against which concrete packing could be cut and worked, securing a further cement skin against the penetration of water to the hearting. It may be argued that the vertical backs of such blocks form a cleaner line of cleavage than would ashlar masonry with undressed backs. The author is of opinion that there is very little choice on this score, provided a sufficient proportion of headers are inserted. A great advantage that concrete blocks hold over cut stone is the rapidity with which they can be manufactured, as well as the saving in cost over cut stone of sufficiently hard quality to be placed on the face of a dam-wall. This is particularly applicable to cornice-blocks, which were quickly turned out with clean and sharp arrises and of uniform dimensions.

The down-stream facing of basalt-concrete was made 6 ft. in thickness on the lower portion of the wall, but this was reduced to 3 ft. on the upper portion, where sections of the sandstone hearting blocks were omitted at 10-ft. intervals and concrete ties were carried through from back to front.

The deep excavation for foundations across the bed of the gorge was carried down vertically, and was made of sufficient width up and down stream to receive a cross section of wall calculated for the greatest total depth below the top. The whole of the excavation was then filled in to the bed-level of the gorge with hearting masonry. The projecting step formed by this filling was joined to the calculated profile of the wall above that level by a flat curve, for the purpose of easing and deflecting flood-waters overflowing the wall during construction. The top levels of the wall during construction were carried up so that a low-level gap was always in existence above this eased-off length, for the passage of flood-waters. The remaining lengths of the dam-wall were constructed to the calculated cross section, the excavation on the up-stream side being taken out of sufficient width to allow of the concrete facing-blocks being placed and pointed to foundation-levels. As a continuation of the up-stream facing-blocks, No. 1

concrete was carried underneath the up-stream 10 ft. of the wall and tucked into a 6 × 3-ft. trench channelled out of the sandstone foundations. The sandstone forming the foundations presented rough surfaces which, when properly washed by a jet of water and grouted, afforded an excellent seating for the base of the wall down-stream of the trench.

PROVISIONS FOR STORAGE DURING CONSTRUCTION.—The arrangements provided for the passage and control of freshets and minor floods during construction consisted of four lines of 48-in. pipes. These are carried through the wall slightly above the bed-level of the river, being open at their up-stream ends and controlled by 36-in. sluice-valves placed at their down-stream ends. The sluice-valves were situated below the center of the temporary gap provided for the passage of flood-water, and were protected by arched concrete hoods projecting from the flattened toe of the wall; these hoods were strongly reinforced with railway rails to withstand the impact of the falling water. The valves were provided in order that the pipes could be closed and accumulations of flood-debris removed from their up-stream ends during construction, if necessary, and for the purpose of storing water if required before the completion of the work. On the completion of the wall the up-stream ends of the four pipes were closed by cover-plates, the two outside pipes were thrown out of use and the two inner ones were retained as a permanent means for the passage of supplies. The permanent supply is drawn off through four penstocks at different levels and then dropped down separate wells into each pipe. The wells and penstock-chambers are fashioned in a rectangular mass of masonry projecting from the up-stream face and tied to the dam by circumferential courses of reinforced concrete; these courses also serve to tie together the projecting mass, which is divided by vertical openings for the insertion of screens to keep timber and debris from the penstocks. The whole is surmounted by a cut-stone house of appropriate design.

The contract for the construction of the work provided for the storage of water before completion, the outlet-valves to be closed when the level of the temporary gap was 80 ft. above the bed of the river. Water, if available, was then to be stored to a maximum level of 100 ft. above the river-bed as work proceeded.

CONTRACTORS AND LABOR.—The whole of the area liable to be submerged by the stored water was cleared by day labor. All the plant required for the construction of the wall was purchased and installed by the Government. The whole of the preliminary work, consisting of the construction of access-roads, the opening of suitable quarries, the laying down of tramways, the laying out of the block-making yard, the preparation of foundations, building a portion of the cyclopean rubble in the deep foundations below the bed of the river, and the installation of plant, was carried out by day labor. A contract was then let for the construction of the wall, all cement being supplied by the Government to the contractor, who also had the use of the plant.

The system of carrying out preliminary work by day labor, and the provision of all necessary plant by the Government, had the effect of widening the area of competition when tenders were invited, as many contractors capable of successfully handling the labor required in the execution of such a work had not the financial means to meet the large expenditure involved by the preliminary operations and the purchase of suitable plant. The plant also had to be gathered from various parts of the world, and arrangements were made for its supply immediately approval was obtained for the construction of the work. It was installed and ready for use by the time the preliminary operations requiring only small plant had been completed.

The excavation of the foundations by the Government, particularly that portion under the bed of the river, also relieved intending contractors of all risks regarding the depths to which excavations had to be carried, and from risks of floods during that period.

The plant provided and installed by the Government cost in position £33,000 ($161,000). A portion of it was actuated electrically with power from a central station. The remainder was driven by separate steam units.

The electric plant consisted of three generating-units of 65 KW. each, supplying current at 500 volts to the following: Two cableways of 1,100-ft. span, suspended from towers 57 ft. in height, one set being stationary and the other traversing. These cables were operated by hoists, the drums being 53 ins. in diameter, giving maximum hoisting and traversing speeds of 200 ft. and 1,200 ft. per minute, respectively, for a load of 4½ tons. There were in addition six 6-ton back-leg electric cranes; two of these were of American manufacture with the winch separate from the crane, this being traversed by means of a wire-rope and bull-wheel; the other four were of English manufacture with the winch attached to the king-post of the crane. The four concrete-mixers of 1 cu. yd. capacity were also electrically driven.

The principal steam-units consisted of six locomotive cranes in the quarries, four of 10 tons, one of 5 tons, and one of 3 tons capacity; one air-compressor for driving rock-drills; two stone-crushers, and various steam-pumps, etc.

All stone for concrete and all firewood, the latter amounting to a very large item, were drawn over a 2-ft. gage railway, 6½ miles in length. Plant and cement were conveyed from the nearest railway station 16 miles distant, both by traction engines and by horse teams.

The experience gained showed that, provided the generating plant had comprised a sufficient number of suitable units, it would have been more economical in such a work to have actuated all plant electrically from a central station. With regard to the cableways, it is more advantageous to have both sets capable of being traversed; if practicable, each pair of towers should be placed at different levels so that they can be traversed to overlap, thus enabling both cables to be brought together to command the upper levels of the wall where space is confined and work with cranes is costly.

The policy of providing plant for the use of the contractor proved satisfactory. Stringent conditions regarding its upkeep, and powers for the Government to step in and make repairs in case of neglect, were provided in the specification. The whole of the plant was returned in an excellent state of repair.

The area liable to be submerged by the stored water consisted of alluvial flats and rocky hillsides covered with eucalyptus timber 18 ins. to 10 ft. in diameter. The large timber was cut off as near to the level of the ground as practicable, and all scrub and undergrowth was removed. The timber on the flats, which, however, formed only a small portion of the whole, could have been grubbed out, but the grubbing-out of timber among the rocks on the hillside would have been very costly; it was therefore decided to treat the whole area as described. It was necessary to leave the large trees for a period of 12 months after felling, before they could be burnt, and even then they had to be broken up with dynamite for the purpose. A thick undergrowth rapidly grew over the area so soon as the big trees were cut down, resulting from the germination of seeds which had lain in the ground for many years, and now for the first time became exposed to warmth and light, and also from the bursting of certain seed-shells through the burning of fires. The whole area had to be subsequently scrubbed and suckered three times. For these clearing operations day-labor methods were considered the more suitable.

A temporary township was established for the occupation of people engaged on the works, the tradespeople, and others connected therewith; and as this was unavoidably situated within the catchment-area, special precautions had to be taken to provide against pollution of the Sydney water-supply. The township was divided into two sections, for married and unmarried men, respectively. For the latter, large barrack buildings were erected and partly furnished by the Government, a charge being made for the accommodation, while married men were allowed to erect their own dwellings under regulation. The sanitary arrangements were subject to stringent regulations, and were under the supervision of a resident medical officer appointed by the Government. The sale of intoxicants was absolutely forbidden.

The amount of material in the completed work is as follows:

| | Cu. yds. |
|---|---|
| Hearting masonry | 111,455 |
| Rubble masonry | 1,975 |
| Concrete in situ | 23,846 |
| Concrete facing blocks | 8,966 |
| | 146,242 |
| Total cement used | 19,000 long tons. |
| Quantity of excavation taken out of foundations by washes, etc | 215,000 cu. yds. |
| Ironwork in pipes, valves, etc | 319 long tons. |

The total cost of the work was $1,602,000, made up about as follows:

| | |
|---|---|
| Clearing | $115,000 |
| Excavation | 237,000 |
| Concrete, etc., in the dam and other works | 1,037,000 |
| Outlet works | 26,000 |
| Road of access | 28,000 |
| River diversion | 19,000 |
| Valve-house | 24,000 |
| Sanitary, medical and insurance | 25,000 |
| Supervision and contingencies | 91,000 |
| | $1,602,000 |

The initial work in connection with the construction of the wall was put in hand in October, 1902, and the actual time covered by the operations until completion was 4 years and 11 months.

The author, who holds the position of Chief Engineer of the Rivers, Water-Supply and Drainage Branch of the Public Works Department, was responsible for the whole work. Mr. C. W. Darley, M. Inst. C. E., who represented the New South Wales Government as Consulting Engineer in London, advised as to and selected the electrical plant, after having examined the various systems in use on the construction of large dams in America. Mr. E. M. de Burgh, M. Inst. C. E., acted as Supervising Engineer. Mr. J. Symonds filled the position of Resident Engineer during the whole of construction, both by day labor and contract, and was responsible for the disposition of the plant and general layout of the construction.

## A New Fireboat for Seattle, Wash.

By M. H. STROUSE.*

One of the most powerful fireboats yet built has just been completed and put into commission for the protection of the rapidly increasing water-front property of the city of Seattle, Wash. For the past 20 odd years, the "Snoqualmie" has done good service along these lines, but the rapid growth of the city now demands more and better fire protection.

The "Duwamish," the new boat, was designed by Messrs. McAllaster & Bennett, Naval Architects, of Seattle, Wash., who also superintended the construction and trials. In the design of this boat the matter of moderate draft and ability to manoeuver in close quarters had to receive special attention.

The selection of the reciprocating type of fire pumps was the result of careful consideration. It was known that several fireboats built in recent years have been fitted with centrifugal pumps and steam turbines for this work and, therefore, the plans were made and bids received for constructing the vessel with either type of pump. The increased cost for centrifugal pumps was found to be about $7,000, after crediting the smaller boiler capacity required. The economy of the steam turbine was not questioned, but it was considered that as the actual pumping time would be very small, the greater fuel consumption of the reciprocating pumps would not be detrimental. The serious effect of salt water and sewage on cast iron in connection with brass, causing corrosion of the cast-iron parts of the pumps, the great distance from the factory should parts require renewing, together with the increased first cost, made it appear that for this particular case the reciprocating pump with solid composition water end would be the most suitable.

The contracts for the construction of the boat were let in segregated form, the hull, machinery and electric installation all being separate contracts; and the city purchased the boilers, fire pumps, electric generator, etc., direct. Under such a system the possibility of collusion between different contractors is apparent, and the opportunity for large bills for extras very great. The result, however, has apparently been satisfactory, since the vessel complete cost $122,400, whereas the designers' estimate, submitted with the plans before bids were called for, was in the amount of $123,112. The lowest bid received for the complete vessel in one contract was from the Willamette Iron & Steel Works, for the sum of $122,475. The above figures do not include hose, which is furnished by the fire department.

### Description of Hull.

The vessel is built of steel throughout, of the flush deck type, with a low trunk running fore and aft for about 55 ft. for ventilation and to accommodate piping. This trunk is low enough so that it is accessible from all parts of the deck, without steps or ladders. The stern is unusual for this type of boat, being of the "compromise" torpedo-boat style, giving increased water-line length and better protection to the twin propellers. The scantlings and shell plating are all extra heavy for a vessel of this size. The after end of vessel up to orlop deck is built as a double bottom, and has a capacity of 8,800 gals. of fresh water. The fuel oil tank has a capacity of 277 bbls., and is fitted into the forward hold. The inside shell in forward hold, engine room and boiler room, and all frames and floors below the platform, together with the fuel oil tank, are covered with bitumastic enamel.

The general dimensions of the vessel are:

| | |
|---|---|
| Length over all | 120 ft. |
| Beam, molded | 28 ft. |
| Depth, molded | 15 ft. |
| Load draft | 8 ft. |
| Displacement | 450 tons. |

No quarters are provided for the crew, as the men live in the fire station on the dock, but as much convenience as possible is provided on board, such as bath room and steam galley for use at fires of long duration.

*222 New Municipal Bldg., Seattle, Wash.

**Pumping Machinery and Fire-Service Piping**

The pumping machinery consists of three duplex fly-wheel pumps, with cylinders 17 ins. in diameter, plungers 10 ins. in diameter by 11-in. stroke, designed for a working discharge pressure of water at 200 lbs. per sq. in., when delivering 3,000 gals. per minute each, or a total of 9,000 gals. per minute. They are also required to deliver a smaller quantity of water at 300 lbs. pressure, with the possibility in view that salt water mains may at some time be installed in the business district, and a discharge opening is provided on the boat for this purpose.

A 12-in. emergency suction opening is provided for these pumps, to which may be attached suction hose, for pumping out distressed vessels or other purposes.

The main discharge piping from the pumps is large and loss of head due to friction was found, on trials, to be low. There are two 16-in. injection valves to supply the three pumps. The discharge is connected to two 14-in. mains running forward to a horse-shoe manifold below the front of pilot house, on which are fitted twelve hose connections for 3½-in. hose. These mains also connect to the large monitor on the top of the pilot house, which has nozzle tips from 4½ ins. in diameter to 5½ ins. in diameter. From the pumps, two mains of 12-in. diameter run aft to the companion deck erection specially built to carry the second monitor, which has nozzle tips of from 3¼-in. to 4-in. diameter. There are also four connections for 3½-in. hose, arranged on the after deck erection, two on either side. The 12-in. and 14-in. fire mains completely encircle the vessel, and are so arranged with cut-out valves that either side or any section might be disabled by blown-out joints without preventing the operation of the rest of the system.

**Main Engines and Boilers.**

The main propelling engines are of the double, vertical, inverted type, and are of heavy and very simple design. Each has two cylinders, 14-in. diameter by 16-in. stroke, mounted on cast-iron columns of "I" section. They are fitted with piston valves operated by Stephenson link motion. Each engine will develop about 450 HP. with steam at 150 lbs. pressure, far more than required for necessary speeds. This allows ample reserve for responding to an alarm at full speed while steam is being raised to working pressure. The engine working parts are all of the best design of sea-going machinery. The twin propellers are of the four-bladed, built-up type, 6-ft. diameter by 8-ft. pitch, with bronze blades, turning out-board.

The boiler installation is worthy of more than passing attention. The difficulty experienced in most fireboats to furnish steam for continuous service at full power is well known. In this case, the boiler problem received special attention with the result that four Mosher water-tube boilers, each with 2,250 sq. ft. of heating surface, or a total of 9,000 sq. ft., were provided. The fuel is California oil, and each boiler is provided with four burners of the Lassoe-Lovekin make. On trial the boilers furnished all the steam required with only three burners in operation in each boiler. The boilers are set in the fire room fore and aft, with 9 ft. 3 ins. between boiler fronts, providing a most convenient and roomy firing platform.

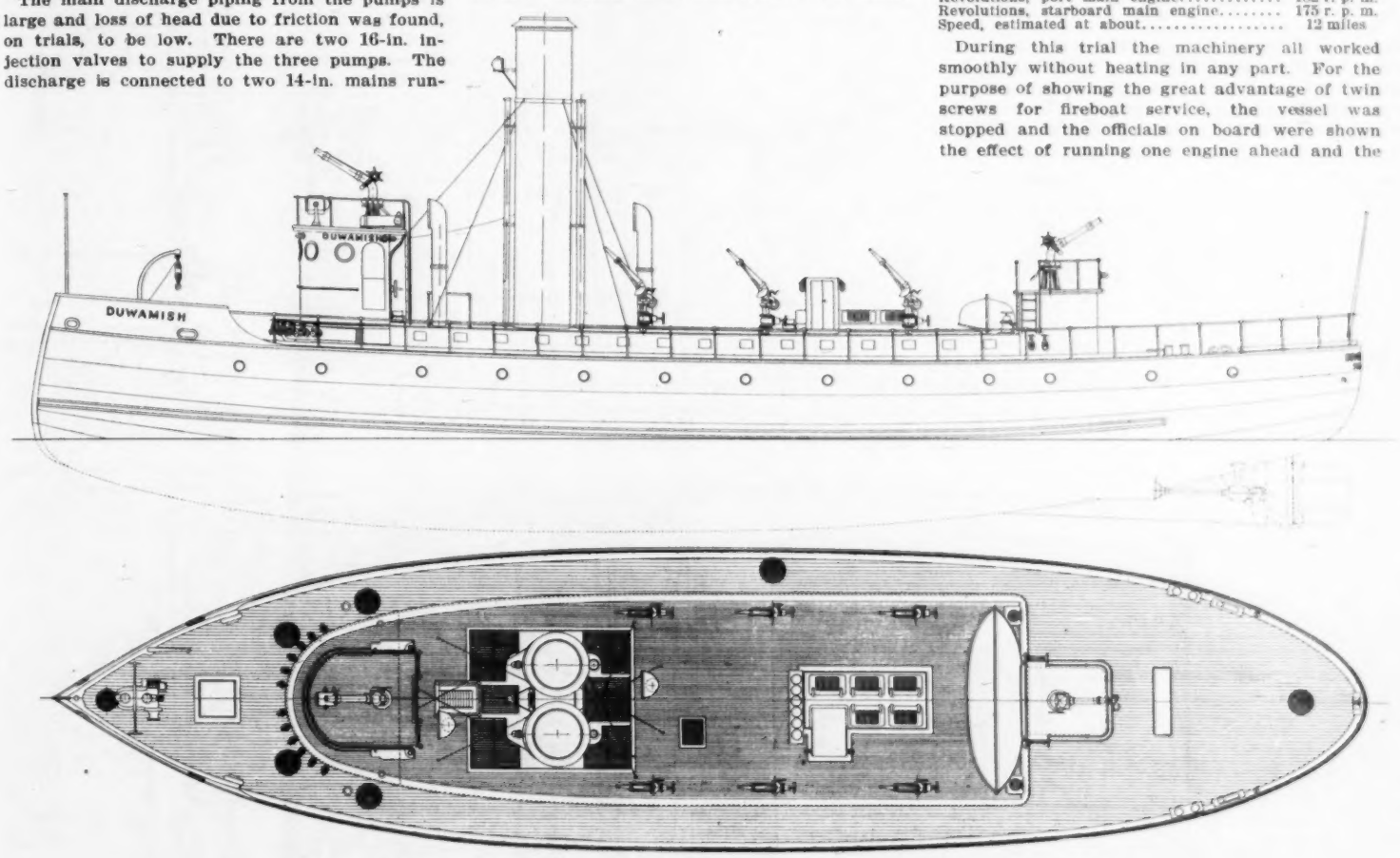



FIG. 1. THE NEW SEATTLE FIRE BOAT "DUWAMISH": ELEVATION AND DECK PLAN.

**Piping and Auxiliaries.**

The steam and exhaust piping throughout is of copper, and is laid out in a most effective and space-saving manner. The main steam pipe is 10 ins. in diameter. Ample condensing surface is provided in a cylindrical condenser, 5 ft. 3 ins. in diameter by 9 ft. 3 ins. long between tube sheets, having a cooling surface of 4,175 sq. ft. Cooling water is furnished by a centrifugal pump, with 12-in. discharge and 14-in. suction openings, direct connected to a 7-in. × 7-in. engine. The auxiliary machinery is all large and capable of maximum performance without forcing. The air pump is independent, 10-in × 20-in. × 15-in. duplex twin beam. Two feed pumps, 9-in. × 6-in. × 10-in. duplex Admiralty. A feed-water heater and grease extractor are fitted.

The electric light plant consists of a 10-KW. turbine driven generator. All wiring is run in iron conduits and fittings throughout are of the highest class. A 15-in. searchlight is mounted on the pilot house, arranged to be operated from the inside. Telegraphs communicate from the pilot house to the engine room, both for the main engines and the pumps; the 'after telegraph is graduated in pounds pressure of water desired at the pumps. Both steam and hand steering gear are provided.

**Description of Trials.**

A number of trials have been made in the presence of the city officials and the engineers of the National Board of Fire Underwriters to demonstrate the manoeuvering, running and pumping ability. On Dec. 6, 1909, the vessel was run for several hours on Puget Sound, but owing to a high wind and rain complete data for this run was not obtainable and no attempt was made to run the propelling engines at maximum speed. The results as obtained were as follows:

| | |
|---|---|
| Steam pressure at boilers | 175 lbs. |
| Steam pressure in receivers, port | 85 lbs. |
| Steam pressure in receivers, starboard | 80 lbs. |
| Vacuum | 25 ins. |
| Revolutions, port main engine | 182 r. p. m. |
| Revolutions, starboard main engine | 175 r. p. m. |
| Speed, estimated at about | 12 miles |

During this trial the machinery all worked smoothly without heating in any part. For the purpose of showing the great advantage of twin screws for fireboat service, the vessel was stopped and the officials on board were shown the effect of running one engine ahead and the other astern. Notwithstanding the high wind, the vessel was turned through a complete circle, as though on a pivot.

At a later date, trials of the pumping machinery were made. The pumps had previously been tested for slip, which was found to be 1%. Pressures were read at the pumps by standard gages, and at the nozzle by a Pitot tube held in the stream. Nozzles were carefully measured by a micrometer. The forward monitor only, fitted with a 5-in. diameter tip, was used on this trial. The three pumps were run at speeds from 220 to 232 r. p. m. discharging from 9,000 gals. to 9,500 gals. per min. at 180 lbs. to 195 lbs. pressure at the pumps. The loss of pressure between the pumps and forward monitor tip at these deliveries was found to be about 30 lbs. Under service conditions, nozzle pressures of 150 lbs. would not likely be used, and at the usual fire stream pressures of 100 to 115 lbs. this vessel should be capable of service of long duration at 10,000 gals. per minute. During this trial steam was easily kept up, with only twelve oil burners in use, leaving four in reserve. The absence of excessive vibration was most noticeable, due to the extra heavy pump foundation.

In actual service, it has been observed that, in responding to alarms, the vessel actually steams at 14 miles per hour.

# Problems in Power Transmission.*

By H. W. BUCK,† M. Am. Inst. E. E.

Since very few water-power situations are near large power markets, long-distance transmission has been necessary for their utilization, and a development in power transmission has resulted on a scale which was not contemplated ten years or so ago. The possibility of marketing very large blocks of power at centers of distribution has reduced the cost per horse-power of transmission line construction, so that very long lines have become commercially feasible.

TOWERS.—The rise in the price of wood and the reduction in the cost of fabricated structural steel has led to the substitution of steel towers for the old wooden poles on many lines. Such steel construction enables higher supports to be used and consequently longer spans, with the resulting economies. Steel supports also eliminate the fire risk. The question of depreciation in a steel tower, due to corrosion, even if galvanized, has not yet been definitely determined, for most tower lines have been in service only a few years. If the steel legs of the tower are installed directly in the ground it is questionable whether the life of this part of the tower will be any longer than that of a wooden pole.

The strength of a tower with its legs in the ground is also uncertain, since the quality of the soil varies to such an extent. If the legs are concreted in the ground, the tower is greatly strengthened and corrosion is practically eliminated, but the cost per tower is thereby in some cases doubled. Unless, therefore, the amount of power transmitted is very large, so that the cost per horse-power of the line is reduced, steel tower construction is almost prohibitive in cost. In order to reduce this cost it is common practice to make the smaller members of the tower not more than ⅛-in. thick. The life of steel members of this small section, even if galvanized, has yet to be determined, although the results on wind-mill towers are encouraging.

SPANS.—The lengthening of the span has been an obvious result of the introduction of steel towers. It reduces the number of insulators and consequently the opportunity for break-downs and has other advantages but it has introduced other difficulties. With the old-fashioned short-span construction common on wooden pole lines the question of sag and strength of conductor was of very little importance. Lines could be installed slack, using soft-drawn conductors, and the strains on insulators and supports could be reduced to a minimum. Conductors on this account seldom broke. The sag was small in any case, and a foot or so more or less made very little difference.

With long spans, however, there is a radical difference in requirements. In order to reduce the height of towers, since their cost increases almost as the square of the height, the conductor must be drawn up to the maximum possible tension. This has eliminated the use of soft-drawn metal for conductors and has necessitated the development of commercial hard-drawn copper and aluminum of very high elastic limit. The long span also requires the stringing of the wire with the greatest care, with accurate observations as to temperature and tension.

The high working stress in conductors necessary in modern long-span lines has introduced new mechanical problems in insulator and crossarm designs. Furthermore, the conductor is stressed so near to its elastic limit at times of low temperature and high wind that a short-circuit on the line is almost certain to burn it enough to cause it to part from reduction in cross section. When a conductor does part under these conditions, the high initial tension is likely to cause considerable damage to adjacent insulators, cross-arms, etc., from recoil. A further difficulty in the case of very long spans has resulted from vibration of the conductor and its crystallization and ultimate breakage at the point of attachment. In such cases it has been found necessary to make the attachment more or less flexible. The suspension type of insulator is specially favorable for this reason.

The economical span length for steel construction under present conditions ranges from about 300 ft. as a minimum to 750 ft. maximum, depending upon a large variety of conditions peculiar to each line. It is impossible to give any formula expressing the proper economical span length for a given line, since so many variables enter into the equation.

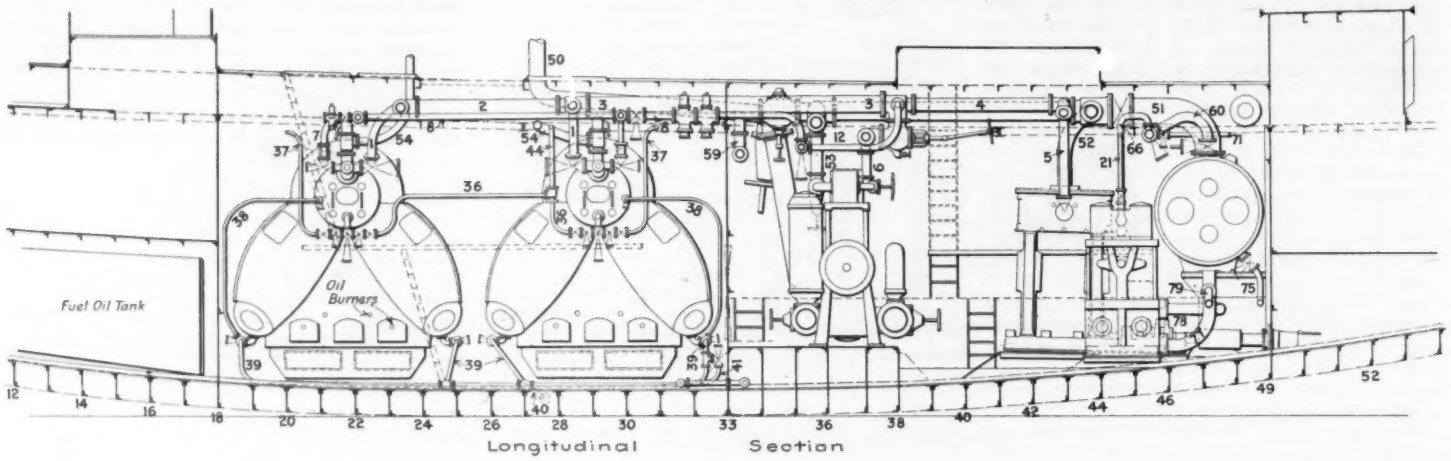
INSULATORS.—Up to about 60,000 volts the standard type of pin-insulator construction gives very satisfactory results. With the rise in transmission voltage above this figure, mechanical difficulties are encountered due to the large size of pin insulator required. The cost of this type of insulator increases nearly as the cube of increase in voltage, above 60,000 volts, and the necessary height of the pin imposes tension strains on the cross-arm which are objectionable.

Probably the most important and radical improvement which has taken place in recent years in power transmission has been the development and introduction as a commercial success of the so-called suspension-insulator construction. It superseded the pin type almost immediately for the very high voltage lines and now is standard for voltages above about 80,000. Its advantages and its successful performance have been definitely established on a number of important transmission systems in operation.

The suspension insulator requires a higher tower than the equivalent pin insulator. This disadvantage is offset by the simplification of the crossarm and the elimination of torsion on the arms and head of the tower.

INSTALLATION OF CONDUCTORS.—Where pin insulators are used, the usual method of construction consists in drawing the conductor up to tension over the top of the crossarms or through the groove in the top of the insulator. Since each pin insulator is a fixed point on the line the conductor when up to tension can be tied in at any insulator and fixed until the next few spans are drawn up, and so on. With suspension insulators the method is not so simple. Usually the wire is slung in snatch-blocks, one hung from each crossarm, and a mile or so of conductors drawn up to tension. The cable is then fixed to some tower with an auxiliary clamp. After this operation it is necessary to transfer the cable from each snatch-block to the suspension clamp on each insulator, and ultimately the auxiliary clamp must be removed.

This extra labor puts the suspension insulator at a disadvantage in cost of construction. There are possibilities



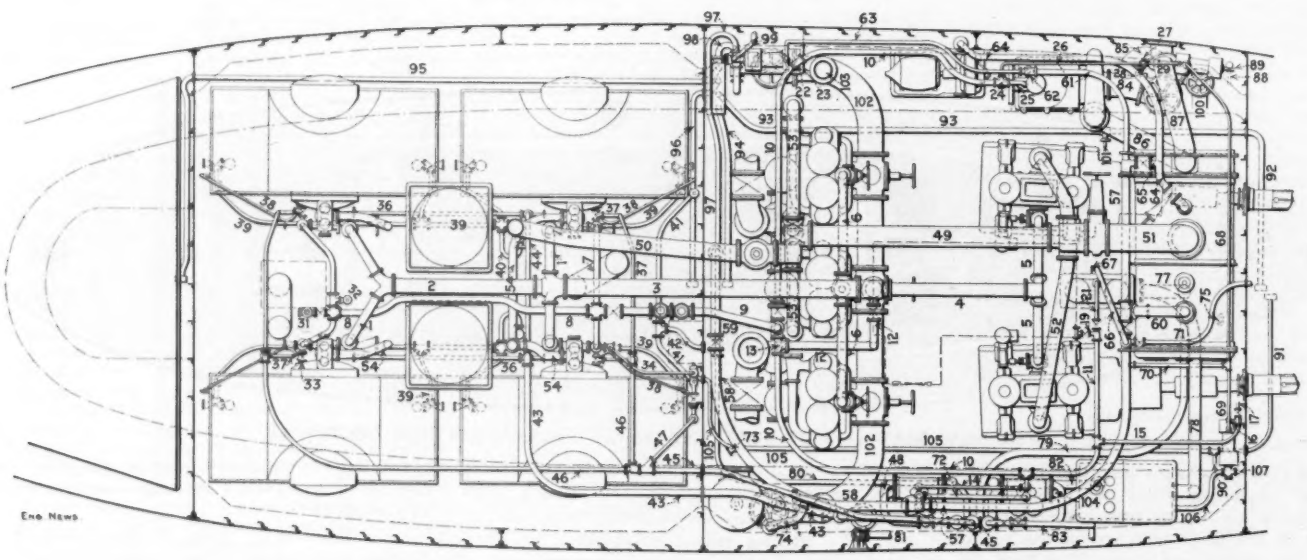




FIG. 2. ARRANGEMENT OF MACHINERY AND PIPING OF THE FIRE BOAT "DUWAMISH": PLAN AND SIDE ELEVATION.

*Abstract of a paper read at the annual meeting of the National Electric Light Association, St. Louis, Mo., May 24, 27.

†49 Wall St., New York, N. Y.

for improvement here, especially in training linemen to this special work. Experience is specially necessary for tying-in conductors at dead-end insulators where the operation is quite complicated.

The most satisfactory method of securing conductors on suspension-insulator lines is to place at regular intervals along the line (a mile or so apart) extra strong towers where dead-end insulators can be installed and the line fixed at these points. These towers should be strong enough to withstand any strain likely to occur on the line. The intermediate towers should be equipped with suspension insulators, but with the conductor clamped thereto so that it can slip through in case of breakage. The intermediate towers need then be only just strong enough to carry the actual weight of the conductors and to resist the overturning moment, across the line, due to wind. At angles, dead-end insulators should be used, with extra strong towers.

Italian engineers carried this principle to an extreme several years ago by using flexible towers as intermediate supports. The arrangement has special merit in connection with suspension insulators, and has recently been taken up actively in this country. It gives promise of economy, especially from the view point of cost of tower assembly and erection.

VOLTAGE.—The success with suspension insulators on the recent 100,000-volt lines in this country has been remarkable, and such lines have actually given less insulator trouble than the early 20,000-volt lines when they were first installed. Since the degree of insulation with suspension insulators can be increased to almost any desired extent without involving prohibitive difficulties, there seems to be no reason in the insulator itself why much higher voltages should not give satisfactory results. There are, however, other considerations which will probably limit line voltage to approximately 100,000 volts for some time to come. The insulation of the line itself is a much easier problem than that of transformers, lightning arresters and substation equipment, and these devices cannot be considered entirely satisfactory even at 100,000 volts in the present state of the art.

Oil switches become of enormous proportion at this voltage and involve the use of large quantities of oil under conditions where the fire risk is considerable. Furthermore, the spacing necessary between phases at 100,000 volts is so great that substation buildings must be very large and expensive. It is questionable whether the economy in conductor cost in a voltage raise from 100,000 volts to 150,000 volts would not be more than offset by the increased cost of insulator towers, substations and operating equipment.

There are other problems incident to the very high line voltages which have not yet been solved. The line-charging current is a serious element on long lines even at 100,000 volts, and the atmospheric discharge loss increases rapidly above this voltage. The spacing between conductors for the latter reason will have to be largely increased as the voltage goes up, and it will probably be necessary to artificially increase the diameter of conductor to reduce the discharge loss. This will increase the wind strains on towers and increase their cost.

It is probable that 100,000 to 110,000 volts is as high a voltage as is justified on a large commercial scale under the state of the art as it is at the moment. It would be well for electrical engineers to be conservative in this regard in the best interests of permanent advancement, since a too rapid rise in line voltage applied commercially is certain to result in unforeseen difficulties and unsatisfactory service which can only retard legitimate development.

REGULATION.—Voltage regulation under the variable load on very long high-voltage lines cannot be considered satisfactory under present conditions. This is due principally to the great inductive drop and the excessive charging current, both of which are exaggerated at 60 cycles. For instance, the wattless leading current in a 100,000-volt, 60-cycle, single-circuit line 150 miles in length is approximately 50 amps. or 8,650 KVA.

This requires a considerable generator capacity to operate even at no load. This charging current magnetizes the generator field so that the voltage will automatically build itself up until a condition of high saturation in the generators is reached. In order, therefore, to maintain normal voltage under these conditions the generator direct-current field must be cut out almost entirely.

The combination is highly unstable. As the load comes on, if it is inductive (such as induction motors) the line-charging current may be neutralized or the power-factor may actually show lagging current as a resultant. The generator fields must then be strengthened to a point which on the no-load saturation curve of the machines would correspond to a voltage much above normal. Assume then that some circuit breaker on the system opens up, cutting off a large block of energy load and also part of the compensating lagging current. The resultant current at the generators immediately changes from lag to lead, the line-charging current again predominating, and the generator voltage may rise as much as 50%. This serious rise is caused by momentary speed rise due to reduction in load, armature reaction due to change from lag to lead, and in addition there is the boost of voltage over the line inductance due to the leading current. Other power users on the system which remain connected to the lines under these conditions will suffer from the disturbance.

This problem in regulation can be solved only by the installation of shunt inductance placed at intervals along the line permanently connected thereto, and so adjusted as to neutralize the line-charging current regardless of conditions in the various receiver circuits.

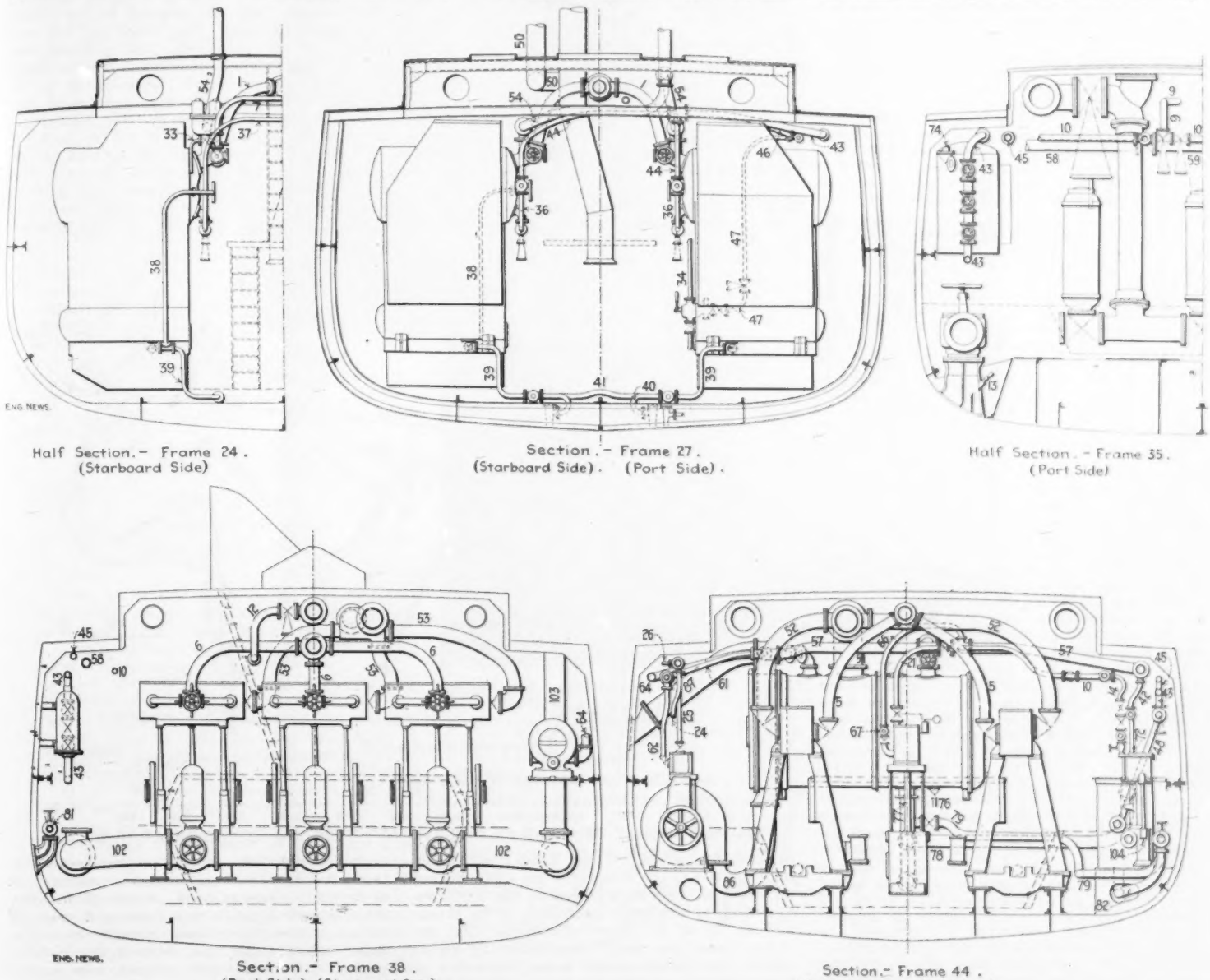



FIG. 3. TRANSVERSE SECTIONS, THROUGH THE HULL OF THE "DUWAMISH"; SHOWING ARRANGEMENT OF MACHINERY AND PIPING.

If it becomes necessary to neutralize the lagging currents of the receiver circuits, rotary condensers should be installed, which operate very satisfactorily. It is not feasible, however, to neutralize the lagging currents in the receiver circuits with the line-charging current if good line regulation is required, since one is a constant and the other is a variable.

FREQUENCY.—While 60-cycle does not compare favorably with 25-cycle frequency for line conditions alone, due to the increased charging current and inductive drop at the higher frequency, the former is coming into more general use on the large transmission systems. This is due somewhat to the necessity of operating in conjunction with existing plants; but there is justification for it in the reduced cost and size of the transformers, which are large and expensive in any case at high voltages. One of the strong arguments formerly used in favor of 25 cycles for transmission is its benefit in rotary-converter operation. On account of poor voltage regulation, however, it is no longer usual practice to install converters on long lines, since the independent voltage control of the motor-generator set is required.

Furthermore, the general adoption of 25 cycles for single-phase railway operation does not look as probable as it did a few years ago; so that greater advantages for overhead work seem to be in the 60-cycle system. Where extensive underground cable networks are involved, 25 cycles is desirable in order to reduce the cable eddy current and dielectric losses and to lessen the charging current.

LIGHTNING ARRESTERS.—Good progress has been made in lightning arresters through the development of the electrolytic type. If a disturbance takes place on a line causing a wave of high voltage the electrolytic arrester allows the surge to pass through it satisfactorily and absorbs its energy. Under these conditions the dynamic current does not follow and the arrester is not overheated. If however, the actual voltage on the line rises, for reasons previously discussed, the arrester breaks down and the current which passes is actually dynamic current flowing at the higher voltage, and here the heat generated in the electrolyte is apt to cause an explosion with consequent ejection of liquid, oil, etc., and permanent damage to the disk units.

It is not likely that lightning itself will be as troublesome at 100,000 volts and over as it is on the lower voltage systems. The insulation of the entire transmission system is so high that the potentials due to lightning are not so likely to cause a puncture, and a point should ultimately be reached where all the apparatus will have sufficient insulation to be practically lightning-proof. Arresters are really more for protection from so-called surges than from lightning. Even these should be reduced as line voltages go up, since the reaction due to any sudden change in line current is proportional to the square of the line current. The higher the voltage, of course, the less the current for a given power, so that the tendency should be to lessen disturbances.

GUARD WIRE.—The steel guard wire installed along the top of many recent transmission lines has given promising results, and the general opinion is that it is a benefit as a protection from lightning. It has an additional mechanical advantage in tying all the towers together and an added electrical use in connecting all the towers so that all must be at the same potential. If it is then necessary to work on a conductor on the line, this conductor can be grounded to any tower and brought thereby to the same potential with every tower, so that work can be safely carried on without danger from shock.

RELIABILITY OF SERVICE.—As long as overhead transmission lines exist as they are under the present state of the art, occasional interruptions to service will necessarily occur. It is better to recognize this and make provision to reduce the duration of interruption. An interruption once or twice a year, lasting a few minutes, will cause very little inconvenience even to the most exacting public utility. The real problem in satisfactory service is to design switching arrangements and provide spare circuits and apparatus so that when trouble does occur it can be located rapidly, cut out and service resumed at once. Resumption of service should never wait upon repairs.

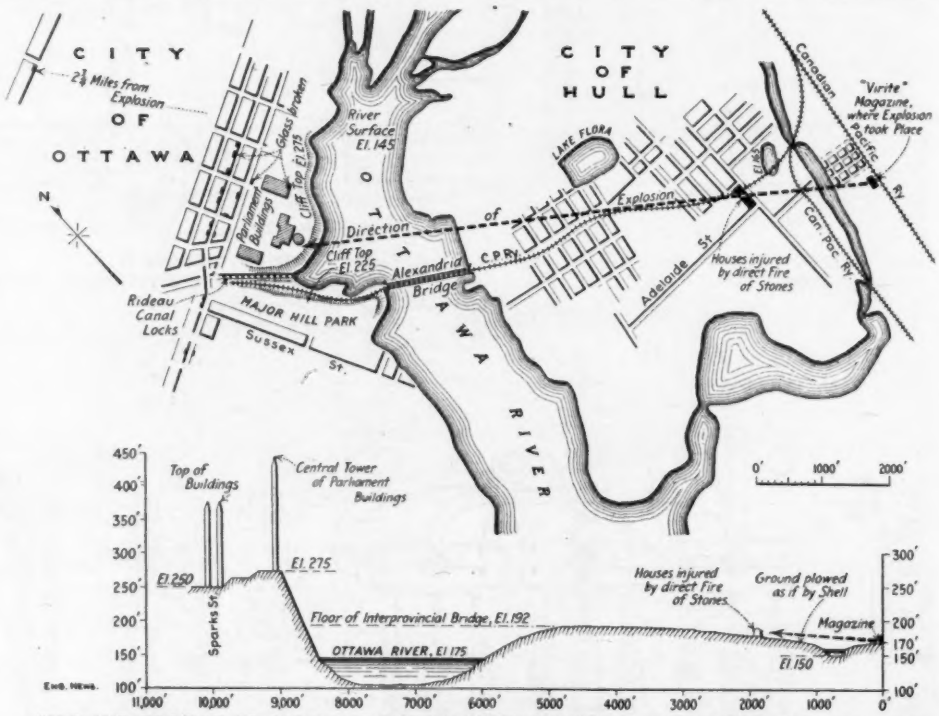
One of the most important elements in case of trouble is effective telephone communication between the various parts of the transmission system. The practice lately has been to remove telephone wires entirely from transmission towers, so that they will not be subject to trouble from the high-tension-conductors. This is especially necessary on the very high voltage lines because of static induction. The latter is more difficult to satisfactorily eliminate than magnetic induction, which usually can be overcome by transposition.

The largest field for future evolution in power transmission is toward high-voltage direct current. Its advantages over alternating current from the standpoint of the line itself would be very great. The effective voltage would coincide with the maximum, and the insulator problem would be reduced 30%. The number of conductors would be reduced to at most two, and possibly one with grounded return would be satisfactory. Line changing current and self-induction would cease to exist and the question of power-factor would be eliminated. The whole problem of power transmission would be vastly simplified and costs would be reduced for construction. Such a development would undoubtedly double the practicable transmission distance. This, however, is not a problem in power transmission, but one in electro-magnetic machinery, and it would involve radical developments and probably some new discoveries. The complications now necessary for the generation and utilization of high-voltage direct current are such that its general adoption would not be commercially practicable.

## The Powder-Magazine Explosion at Hull, Quebec.*

The effects of the explosion of a large quantity of high explosive can be foretold with a fair amount of accuracy when the explosive is loaded into blast holes, but this is not the case when the explosion occurs in the open. Some of the peculiarities of the results of the recent explosion of 5,000 lbs. of "virite" in a powder magazine at Hull, Que., are brought out by the accompanying plan and profile.

The explosion, as briefly noted in our issue of May 12, 1910, took place at the plant of the General Explosives Co. on Sunday afternoon, May 8, and was the result of a fire which burned for about an hour before reaching the explosive. According to published statements of its inventor, Mr. E. A. Le Sueur, of Ottawa, Ont., the "virite" itself has been demonstrated by experiment to be non-explosive under the action of flames alone. It is conjectured that the "virite" in the main magazine was detonated by the preliminary explosion of a supply of fulminate-of-mercury caps in a warehouse adjoining it.




MAP AND PROFILE OF SCENE OF THE "VIRITE" MAGAZINE EXPLOSION AT HULL, QUE.

The plant of the General Explosives Co. comprised a half-dozen buildings which, with the exception of the magazine, were frame structures sheathed with corrugated iron. These buildings were from 25 to 40 ft. apart; the magazine was only about 30 ft. from the nearest building, the warehouse. The magazine, in which were 100 50-lb. cases of "virite" cartridges, was a square structure with outer dimensions of 20 ft. on a side. It had no windows and only one door. In accordance with the Provincial requirements, its walls were of solid masonry, 2 ft. thick.

The principal damage done by the explosion was due to the flying fragments of the heavy stone walls. About 40 houses in Hull were heavily damaged, some beyond repair, and eleven persons were killed and many others badly injured by these missiles. A heavy secondary damage, involving a loss of several thousand dollars in broken windows, was caused by the concussion of the air. Scarcely a window in Hull was left intact and even in Ottawa many windows were broken at a distance of two miles and more from the explosion.

The force of the explosion was apparently not evenly directed toward all points of the compass, but seemed to be in great part concentrated along a line running in an approximately southeast direction, as indicated on the accompanying sketch map. This effect was due very possibly to earlier failure of the southeast corner of the wall of the magazine. The southeast corner, due to structural weakness or to the position of the explosive, may have given way slightly before the rest of the wall and opened an outlet for the main force of the explosion.

This theory is well borne out by both the direct and secondary effects of the explosion. The walls of a frame dwelling house about 2,200 ft. southeast of the magazine (see illustration) were injured by stones flying in an approximately horizontal direction, and the sloping ground between this house and the magazine was furrowed as though by cannon balls. A line drawn from the magazine through this house and produced toward Ottawa would pass through the parliament buildings and that part of the business section of Ottawa which suffered most heavily from window breakage. The furthest windows broken by the explosion, of which any record is available, were at a distance of 2¾ miles from the magazine in the same general southeast direction.

The glass of the windows broken in Ottawa fell outward, a phenomenon not infrequently noted in connection with accidents of this sort. It is conceivable that the blast, or air current, caused by the explosion had assumed an upward tendency at the distance of 1½ or 2 miles, and that the air in the Ottawa streets was thereby sucked upward. This would reduce the atmospheric pressure on the outer window surfaces and the unbalanced normal pressure inside the buildings would push the glass outward. A recording barometer at the Rideau Club in Ottawa is reported to have shown a momentary reduction of pressure of about 9 lbs. per sq. ft.

*From information furnished by Mr. C. R. Coutlee, Ottawa, Ont.

## Large Diameter Shot Drilling in Concrete.

Some large-diameter core-drilling done by the War Department recently demonstrated the complete feasibility of cutting core holes of remarkable size with drills of the chilled-shot type. The work done was in concrete, and the holes were 29 ins. in diameter (drill bit 28 ins. outside). The builders of the drilling-machine, however, say that in their opinion holes up to 60 ins. diameter are practicable, using chilled-shot drills.

A graphical demonstration of the work mentioned is given by the two photographs herewith, showing respectively the 29-in. hole and some of the cores taken from it. A special complication was the fact that the hole was to be drilled *at a very flat angle*, namely, 54° 22′ from the vertical. It had been supposed that this would interfere with the successful working of the shot and bit, but actually no trouble was experienced.

SPEED OF DRILLING.—In the Army work, to which the photographs relate, the following results were obtained (as reported by Capt. H. L. Wigmore, Corps of Engineers):

Bit, 28 ins. diam. Inclination of hole, 54° 22′ from vertical. Concrete.

| Date. | Depth drilled, inches. | Net drilling time, h. | m. |
|---|---|---|---|
| April 18 | 37 | 2 | 40 |
| April 19 | 36 | 1 | 0 |
| April 20 | 31 | 2 | 0 |
| 8-in. steel I-beam cut through | | | |
| April 22 | 33½ | 1 | 15 |
| 2-in. w.-i. pipe cut through | | | |
| Total | 137½ | 6 | 55 |

Where the drilling was done the headroom was exceedingly limited, restricting the drilling to short cores. The total running time on each of the four days listed was much greater than that stated, due to various delays.

WEAR, ETC.—From the same work the following figures are reported:

In cutting 14 ft. of hole, wear of bit estimated at $5.25; oil, waste, shot, etc., $2; total, $7.25.

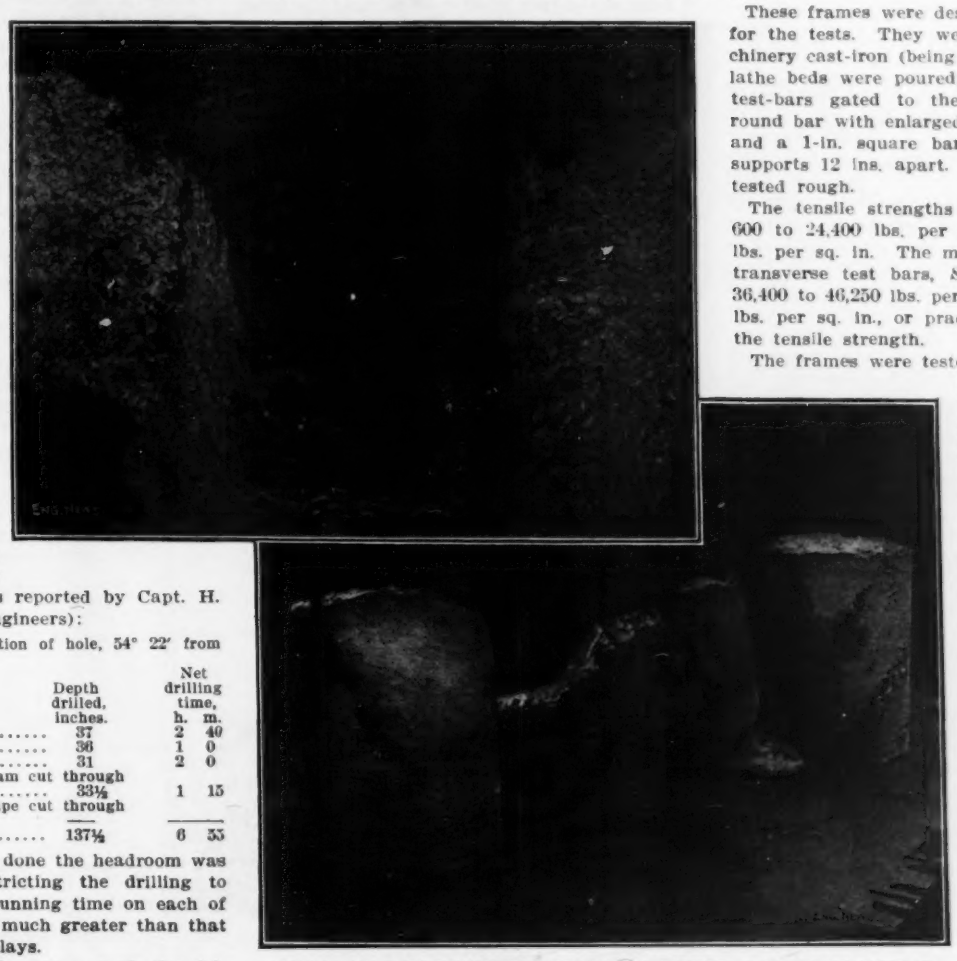
In cutting 6 ft. of hole, wear of bit estimated at $6; oil, waste, shot, etc., $1; total, $7.

The sum of these two runs gives a material cost of $14.25 for 20 ft. of hole.

The drilling machine used was a specially built drill, designed for the work by the Terry Core Drill Co. (to whom we are indebted for the photographs and data). The drill was rotated by an electric motor at a speed of 125 r. p. m., giving a peripheral speed of drill of about 1,000 ft. per min. The feed was by hand, by means of two feed-screws at the rear of the drill-head.

It was found that the production of sludge in the hole was rapid enough to close all minor seams or openings, without losing the water. Even the 2-in. pipe cut through by the drill did not give trouble by drawing off the water. The variable texture of the concrete cut through may be seen from the pictures.

It may be judged that if the production of holes of diameter 30 ins. and larger proves as readily feasible in general practice as it was here found to be, a large range of uses for this class of drilling holes ought to develop. Shot drilling has been carried on in sinking cylinder holes for plunger elevators, up to diameters of about 20 ins., with regular success. These are, of course, truly vertical holes, a different problem from inclined holes. In mining work, particularly, large-size drill-holes can be adapted to numerous uses. Even in civil engineering construction work there are many cases where drilling of large diameters in rock should prove a great aid to the constructor.



DRILL-HOLE IN CONCRETE, 29 INS. DIAMETER, A ND FOUR OF THE CORE PIECES TAKEN FROM IT.

(Drilled with a chilled-shot machine of the Terry Core Drill Co., by the U. S. War Department. Inclination of hole, 54° 22′ from vertical. A special machine was built to give this angle of swing and to handle so large a bit. An 8-in. I-beam and a 2-in. water-pipe were cut through, as the cores show.)

## Breaking Tests of Cast-Iron Jaw Frames.

The ordinary uncertainties in determining the strength of cast-iron beams are complicated in the case of jaw frames, like those of punching and riveting machines, by the curvature of the throat section. It is a well-known fact that the theoretical neutral axis of a cross-section of a curved beam is not in the center of gravity of the section, but lies nearer the concave edge. In the case of crane-hooks and chain links the formulas proper for curved beams give results agreeing with test figures better than the straight-beam formulas. Whether the same would be true of curved cast-iron beams, like the throat portions of jaw frames, is not obvious, especially because such frames have a large tensile stress on the throat section, in addition to the bending moment.

Some actual breaking tests of jaw frames to determine this point were reported by Prof. A. L. Jenkins, of Cincinnati, O., at the recent convention of the American Society of Mechanical Engineers.* The tests are determinations of breaking loads only, and were not intended to show the stress-relations at the relatively low stage of working loads, where the proportionality of strain to stress may be supposed to be not greatly departed from. The results therefore do not give evidence of the applicability of formulas or working stresses, but they do indicate what formulas or coefficients may be used in estimating the ultimate strength of such frames. This latter is important for the purpose of proportioning breaking-pieces in machines having cast-iron jaw frames.

The frames tested had a throat depth of 6 to 7 ins., and a throat width of 3 to 6 ins. The frame dimensions at the back of the throat ranged for width from 4 to 5 ins., and for thickness from 2½ to 3 ins.; the thicker ones were ribbed sections, with web 0.45-in. thick, inner flange 3 ins. wide, and outer flange 2 ins. wide, while the 2-in. frames were solid, of rectangular section. A number of the ribbed frames had the ribs planed to narrower width at the throat.

These frames were designed and cast specially for the tests. They were made of a good machinery cast-iron (being from a heat from which lathe beds were poured). Each frame had two test-bars gated to the main casting, a 1-in. round bar with enlarged ends for a tension test, and a 1-in. square bar for transverse test on supports 12 ins. apart. These were cut off and tested rough.

The tensile strengths found ranged from 18,600 to 24,400 lbs. per sq. in., averaging 21,260 lbs. per sq. in. The modulus of rupture of the transverse test bars, $S_r = Mc/I$, ranged from 36,400 to 46,250 lbs. per sq. in., averaging 40,960 lbs. per sq. in., or practically twice as high as the tensile strength.

The frames were tested in a standard 100,000-lb. tension machine, by means of forged steel stirrups engaging the jaws and bearing each on a small projection cast on the face of the jaw with a view to localizing the bearing at a definite point. The loads required to produce a break ranged from 5,200 lbs. to 15,300 lbs.

On the basis of the observed breaking loads, the tensile stress in the inner side of the throat at fracture was computed by three different formulas for each specimen:

(1) The ordinary bending formula applied to combined bending and direct stress,

$$S = \frac{Mc}{I} + \frac{W}{A}$$

(2) the curved-beam formula, credited to Résal; and

(3) a complex formula devised by Pearson and Andrews, which attempts to take account of the influence of distortion.

It is assumed that the tensile stress at failure, computed by the formula from the breaking load, should agree with the tensile strength shown by the test-bar. Or, better, as the unit strength of a large casting is less than that of a small one, the computed failure stress should be lower than the test-bar strength, rather than higher. Now it appears from the tabulated results of Prof. Jenkins that the stresses given by the first formula are the lowest, and are not far below the tensile strength shown by the test-bars; those of the second formula are generally well above the test-bar strengths; and those of the third formula are very far above the test-bar strength. Averaging the whole set of calculated results for each formula, we find

Formula 1, 18 values, av. 15,725 lbs. per sq. in.
Formula 2, 15 values, av. 22,800 lbs. per sq. in.
Formula 3, 13 values, av. 32,750 lbs. per sq. in.

These are to be compared with the average tensile strength of the test-bars, 21,260 lbs. per sq. in. While the value from the second formula comes closest to this, the author concludes that because of the known decrease of strength of castings with increase of size, the first formula, that is the simple beam formula, gives the most accurate indication of the strength of these frames. Putting this in other words, to estimate the breaking strength of such a frame we are to find the area and section modulus of

*"The Strength of Punch and Riveter Frames Made of Cast-Iron," published in the May, 1910, issue of "The Journal, American Society of Mechanical Engineers."

the throat section, and the lever-arm $l$ of the load, and then, the tensile strength of the metal being $S_t$, we compute from the formula of stress

$$S_t = \frac{Mc}{I} + \frac{W}{A} = \frac{Wlc}{Ar^2} + \frac{W}{A} = \frac{W}{A}\left(1 + \frac{lc}{r^2}\right)$$

the breaking load

$$W = \frac{A\,S_t}{1 + \frac{lc}{r^2}}$$

The frames tested did not in all cases break at the throat section; in fact just half of them either broke in one shank or broke diagonally or irregularly in the throat. This was most notably the case in the ribbed frames, and these displayed a marked tendency to break along the junction of web with inner flange. At this point evidently a tensile stress exists, tending to pull the inner flange away from the web. The computed results do not attempt to take account of stresses other than the normal stresses on the throat section. It happens that the lowest individual stresses given by the simple beam formula correspond to irregular breaks, so that if only satisfactory throat fractures were counted the average failure stress shown by this formula would be raised into even better agreement with the test-bar strength.

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THE ONTARIO ELECTRIC-POWER SYSTEM, being designed and built under the direction of the Ontario Hydro-Electric Commission to supply power from Niagara Falls to municipal distribution systems in the province, is soon to be placed in operation, according to the Toronto "Globe" of June 6. It is reported that the Ontario Power Co. now has the current capacity in its Niagara substation. The transmission-line towers are all erected, with the exception of the special ones supporting the spans across the Welland Canal and at the entrance to Toronto. Six companies are at work stringing the wires. It is expected that power will be on part of the line in a few weeks more and that the entire system will be in operation by August.

## Structural Details of the Columbia Theater, San Francisco.

By MAURICE C. COUCHOT,* M. Am. Soc. C. E.

The new Columbia Theater in San Francisco is situated on Geary St., near Mason, in the future center of the main hotel district. The theater proper occupies a lot 98 ft. × 137 ft. 6 ins., with a wing at the rear of 40 × 50 ft., used for dressing rooms, property, scenery space and stage entrance. The main building is entirely fireproof, while the wing is a brick building with wooden floors.

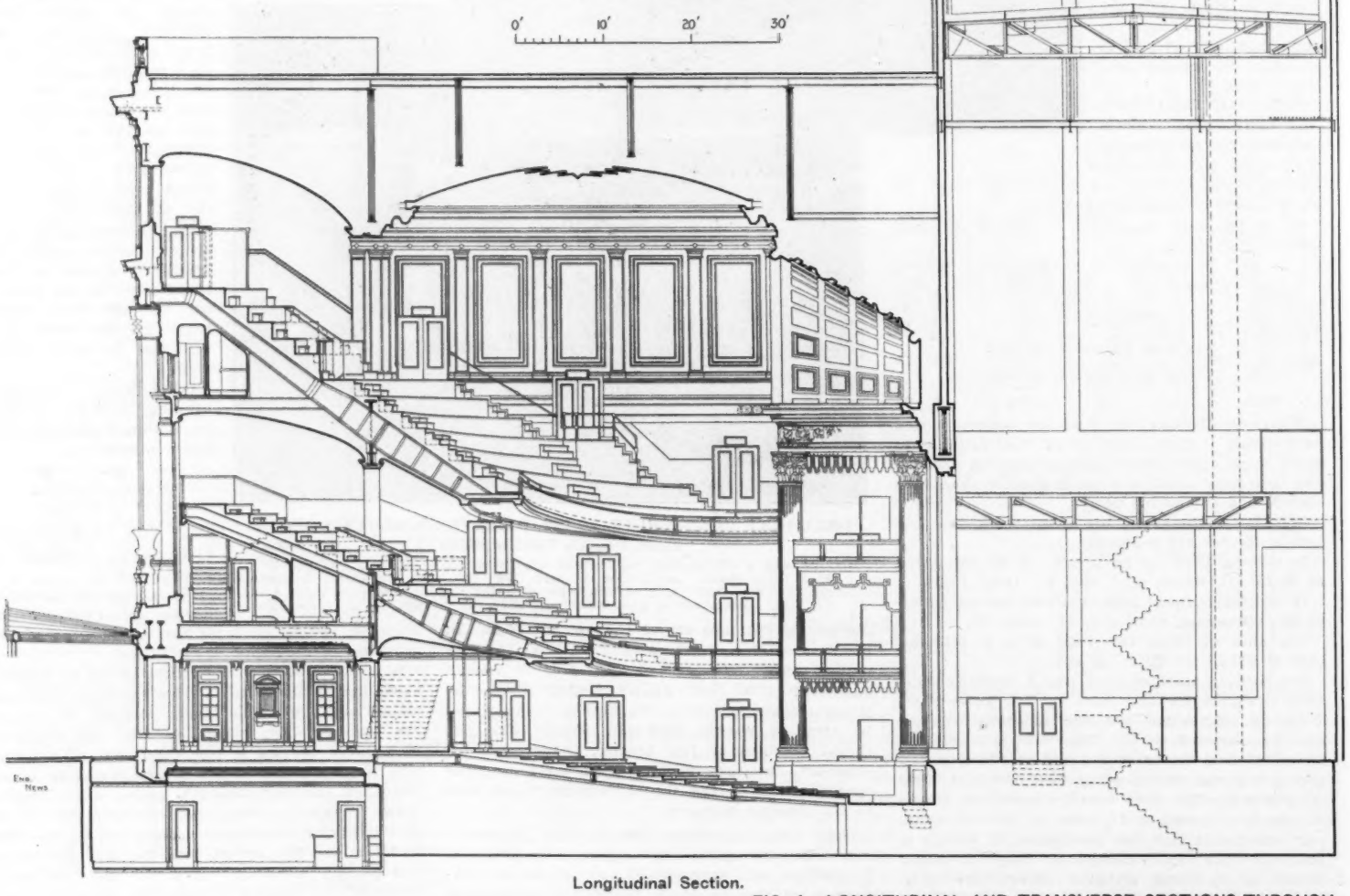
The dimensions of the stage are 40 × 98 ft. The auditorium, 98 × 100 ft., has a total seating capacity of 1,600. The auditorium consists of an orchestra, or main floor, one balcony, one gallery and three tiers of boxes on each side. The basement contains the heating and ventilating plant, and provision is made for the musicians' pit, a café, gentlemen's toilet, and in addition to these a reinforced-concrete water tank for fire protection.

In designing this theater special care has been taken to provide for a large number of exits. The vestibule is of ample size, being 40 ft. wide by 20 feet deep, and the main stairs to the gallery and balcony being 6 ft. wide. The gallery stairs are entirely separate. The exits, 20 in number, open into open courts which are on each side of the auditorium.

The structural part of this building consists of a self-supporting steel frame, designed to carry all the dead and live load of the structure. The floors, walls, roof and stairs are of reinforced concrete except the front facade which is of fire-pressed brick and highly-decorated polychrome terra cotta; the lobby is finished in Caen stone. All the steel in the framework is enclosed in concrete extending outside at least 3 ins. for columns and 2 ins. for beams and girders. The main roof trusses over the auditorium are not encased in concrete, on account of the heaviness of that material, but are instead protected with a wrapping of metal lath and plaster.

In order to procure an unobstructed view of the stage it was necessary to carry the balcony and gallery floors on cantilevers. The construction of these floors is shown in the framing plan in Fig. 2, the upper half of which applies to the gallery and the lower half to the balcony. Taking up the balcony first, it will be seen from Fig. 2 that four interior columns, Nos. 60 to 63, were placed along a line parallel to the front wall and about 25 ft. inside of it. Upon these columns the cantilevers carrying the balcony react, taking their bearing of Cols. 49 and 51, and their symmetrically opposite columns, 53 and 51, all of which are outside of the seats in the orchestra and hence do not obstruct the view on that floor. The balcony, then, is supported mainly on these four cantilever girders, which carry two circumferential girders, varying in depth from 18 to 24 ins. These girders in turn carry the radial beams, 10 to 12-in. I-beams, and the extension brackets which have a circumferential 8-in. channel of the outside end. All of these details are found by examination of Fig. 3.

In the gallery it will be seen from Fig. 2 that the frame is carried from the main exterior skeleton by four cantilevers disposed symmetrically by twos on either side of the longitudinal center line of the building. The outside one of the two cantilevers rests on column 60 and takes its reaction at column 70 A in the front wall of the building. Each of the inside cantilevers rests on the heavy cross gallery girder, extending between column 60 and its symmetrically opposite column 63, and takes its reaction in the wall girder in the front of the build-




Longitudinal Section.

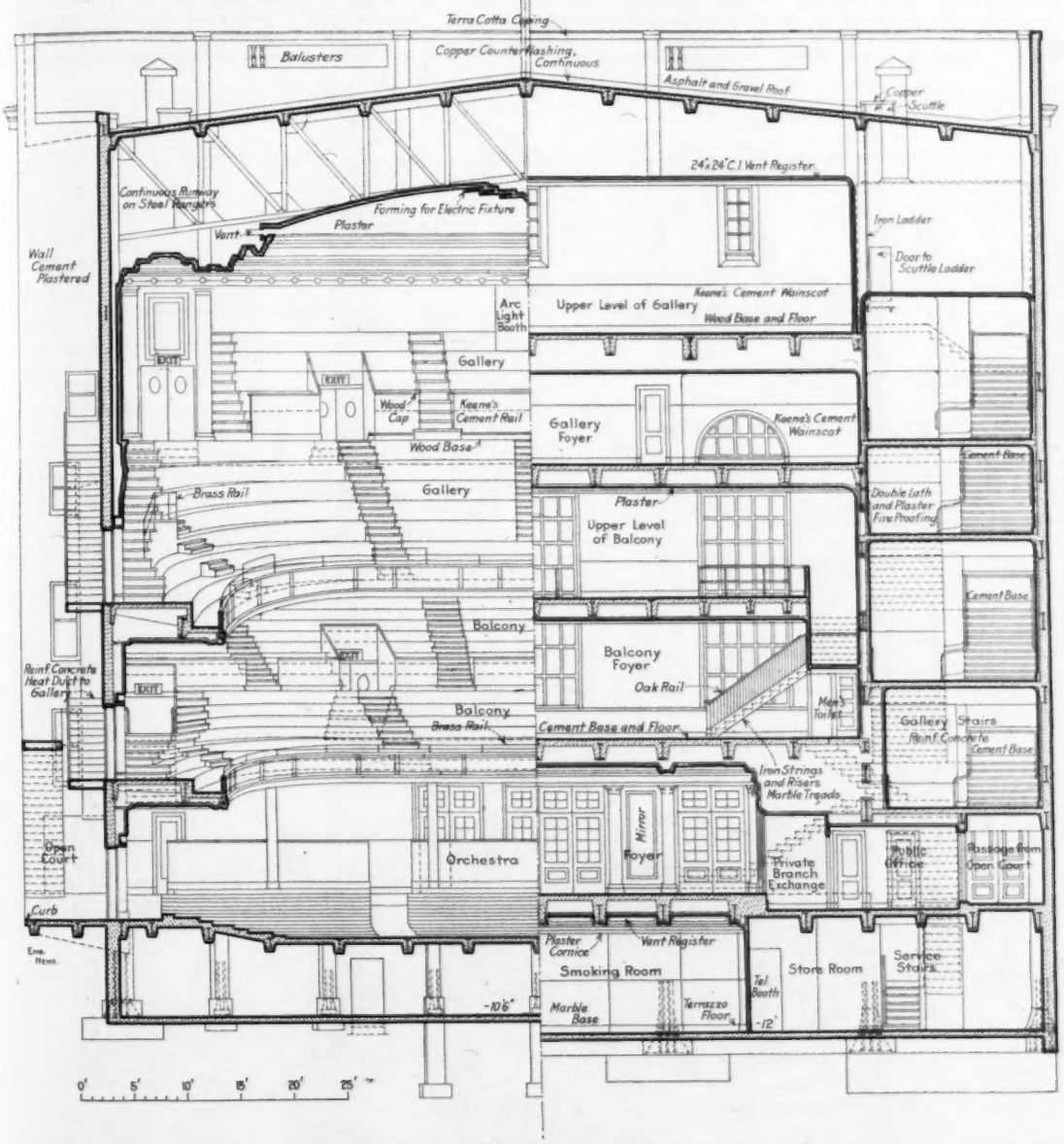
FIG. 1. LONGITUDINAL AND TRANSVERSE SECTIONS THROUGH

*Couchot & Thurston, Engineers and General Contractors, Wells Fargo Building, San Francisco, Cal.

ing. The outside cantilever has a bend in plan as well as the slope in elevation to carry the balcony, but the inside cantilever is straight in plan.

The details of each of the two are shown in Fig. 3. As will be seen there, and also in Fig. 2, these cantilevers carry an outside curved 8-in. channel and one intermediate cross-girder, a 20-in. I-beam in the middle panels and a 24-in. I-beam between the outside cantilever and the wall columns. Radial I-beams from the main gallery girder across the intermediate cross-beams carry the stepped floor.

Details of the heavy gallery girder between columns 64 and 59 are shown also on Fig. 3.




Transverse Section.

THE COLUMBIA THEATER BUILDING, SAN FRANCISCO.

In addition to the legal protection against fire, which includes the construction of the framework as described above and the ordinary fire hose attachments, there has also been installed a complete sprinkler system in the stage space.

The building was designed by Bliss and Faville, Architects, with the writer as consulting engineer, and was built by the Ransome Concrete Construction Co. It was opened to the public during the past winter.

A LAWSUIT TO COMPEL WATER PURIFICATION at Trenton, N. J., has been instituted in the Court of Chancery by the New Jersey State Board of Health. This action follows the notice of the Board to purify the water supplied to Trenton by June 15. It appears from press despatches that the Trenton Water Board took steps to install a hypochlorite plant, but that objections made by the local board of health prevented this.

## The Design and Working of a Modern Refuse Destructor.*

By WILLIAM F. LOVEDAY.†

The general trend of development and progress in destructor practice, more particularly during the past two years, has been on the following lines:

(1) The amelioration of the conditions for the workman in the destructor house.

(2) The introduction of details in construction which ensure fairly high temperatures and a normal ruling condition in the furnace proper.

More efficient means have been introduced for the ventilation of the destructor house, and this is a step which is undoubtedly in the right direction. It is well known that, in any plant that is not strictly up to date, a visit to a destructor plant is synonymous with dust, and the experience could never be looked forward to with anything but feelings of dismay and prospective discomfort. In up-to-date plants ventilating ducts are provided, and the house is so constructed as to permit of the air being renewed from four to five times per hour. The vitiated air is withdrawn through these ducts and led to the fan inlet, from whence it is propelled to furnace ashpits.

In this direction, also, means have been introduced for facilitating the clinkering of the fires. This is by common consent the most laborious operation in the whole cycle in destructor working, and anything that can render easier the clinkering of the fires would be hailed by the fireman, at any rate, with the utmost satisfaction.

Taper castings have been introduced which form a line of cleavage between and in the grates, and much facilitate the breaking up of the fires before withdrawal.

Although there are several different firms who specialize in destructors, yet there are practically only two groups or types, namely, the "single cell" and "continuous grate."

These may be again subdivided or classified by the method adopted in feeding the refuse into the furnace, namely—

(1) Top Feed. In which the refuse is fed in through the top directly on to the fire or on to a drying or desiccating hearth and then pulled forward on to the firebars.

(2) Back Feed. In which the refuse is fed in through an opening at the back and clinkered from the front.

(3) Front Feed. In which the refuse is led in through the front and clinkered from the same opening.

With regard to the top feed, although possibly there is considerably less handling, yet there are grave objections so far as obtaining good results from the combustion and evaporization point of view. Should a load arrive which is either very wet or contains an unusual quantity of tins, earthenware, bottles, or other incombustible matter, it must of necessity go into a particular cell, with the consequent effect of reducing very considerably the temperature in that cell. Again, the refuse has to be pulled forward on to the bars, and it is difficult to get an even thickness and uniform density over the grate when handling long and heavy firing tools over a hot fire, with the result that the forced draft will take the line of least resistance and will escape through the thin parts, to the detriment of the thicker portion which most requires its aid for a complete and perfect combustion. The front or back feed enables the stoker to apply the refuse more evenly and with more discretion, and although the method of charging with the shovel by hand has been described as putting it on by the spoonful, yet to obtain the highest efficiency the makers of mechanical stokers have been employing this method of small quantities at a time with the best results.

In the single-cell type of destructor the cell is an isolated furnace, having an opening through which the refuse is delivered on to the grate bars, and an opening at either the back or front for the outlet of the products of combustion. These latter pass into a main flue which is common to a number of cells built in parallel.

The cell being isolated, the process of combustion must go on unaided by any adjoining fire, and the temperature obtained depends entirely on the quality of the refuse with which it is charged.

There is a type of furnace which consists of two cells having a boiler between, so that the gases evolved in each cell pass immediately under the boiler, and are, consequently, cooled before complete combustion has taken place. It has the further disadvantage that, at the time of clinkering, the admission of cold air must adversely affect the boiler, having regard to the fact that the boiler is in such close proximity to the cell.

The continuous grate is, as its name implies, a number of grates in line, each having a separate ashpit, but with the space above the firebars communicating; that is to say, the gas is passed the whole length of the series of grates into a combustion chamber, and from thence to the boiler. A charge put on any one grate must naturally receive a large amount of assistance from the other fires, and the time taken in the initial ignition and combustion must therefore be considerably less than in the single-cell type.

The great fluctuation of temperature in the single cell affects the firebrick lining very seriously, due to expansion and contraction. This is taking place between each operation of clinkering, about every two hours. This fluctuation is reduced to a minimum in the continuous grate, for the reason that there are always other fires in the furnace at the time of clinkering any one fire.

There can be no doubt, however, that the continuous-grate type of furnace construction is being looked upon with much greater favor, and a few words might be

*Slightly condensed from a paper read before the Incorporated Association of Municipal and County Engineers, Westminster, March 26, 1909.

†Borough Surveyor, Stoke Newington, England.

said with regard to the leading features which characterize the best-known systems of this type.

It may be laid down that the following are absolutely essential features in the design of any furnace that can reasonably fulfil the primary objects for which it exists, viz. the complete destruction by fire of obnoxious matter without nuisance, and general provision for the utilization of the heat generated in the process:

(1) A continuous furnace chamber with the grate laid off in sections, each section independently controlled and so operated that it is a complement of the others.

(2) Provision for heating and regulating the air-supply for the necessary forced draught.

(3) A combustion or dust settling chamber.

(4) Steam generator.

The rate of burning in a continuous grate is higher than in an isolated cell. This rate of burning is materially increased if the arch over the grate is undulating, which causes the gases in one fire to be deflected on to the next, and again from that on to a third. The gases distilled from the green or newly-charged refuse provided. This is placed in a position convenient of access for the firemen, and just opposite the charging door to the furnaces. It is usual to provide for approximately half a day's supply of refuse in the bunker, but, of course, the hours of collection in general determine the amount of storage that should be provided for.

The refuse is shoveled direct from the hopper and spread over the furnace grate in one operation by the fireman.

Stage 2. At this stage the utility of the continuous furnace chamber and sectional grates is at once put into effect, as also No. 2 of the essential features in the furnace design, viz., the heated air-supply. Whenever the material is charged it is ignited by the flame from the adjoining fires, and the temperature of the furnace chamber is further increased by the forced-draft air-supply, which is heated by means of the air-heater or regenerator. Control and regulation of the air-supply are of the utmost importance, and for this purpose a special valve is provided which can be manipulated and adjusted to meet all conditions.

through which the gases pass down a series of tubes, whilst on the outside of the tubes the air is driven from the fan into the ashpit.

There is thus a good exchange going on, the waste gases are made to give up a large amount of their heat to heating the air for forced draft. The heated air on entering the furnace absorbs whatever moisture there may be in the fuel, thereby saving the fuel to that extent which it would otherwise have to give up in the absorption of its own moisture and thus adding increased calorific value to an otherwise poor fuel. This is therefore a very important feature to bear in mind, that heated air rapidly takes up moisture from the refuse and thus materially decreases the time taken for burning. It also is a well-known fact that air heated previously to being discharged into the furnace has the effect of increasing the temperature about twice the temperature of the air so delivered.

The advantage of heating the air may be expressed in terms of coal. Thus with using air at a temperature of 300° F. is approximately equivalent in effect to the

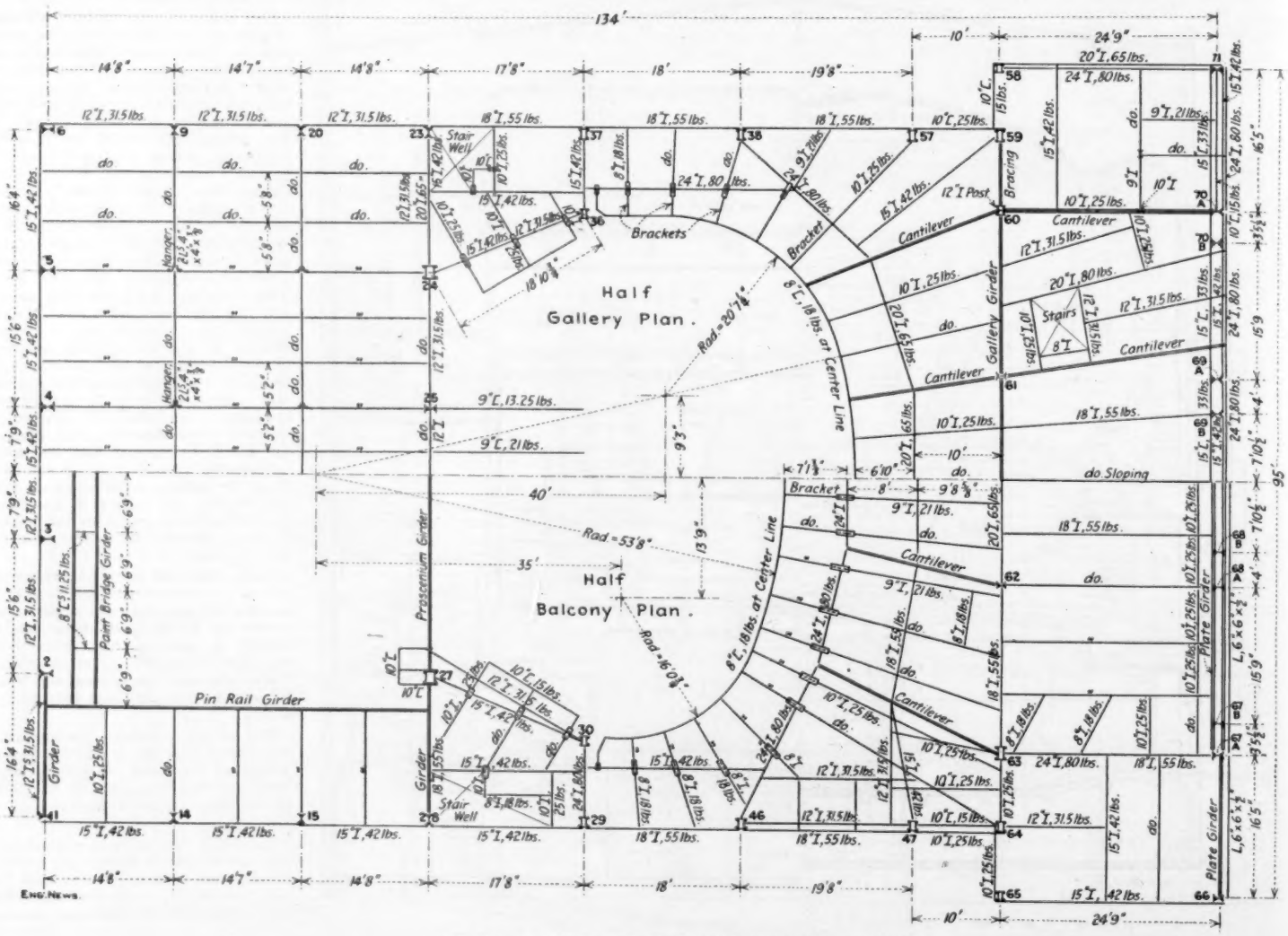



FIG. 2. PLAN OF BALCONY AND GALLERY FRAMING.

must be more thoroughly cremated when brought into contact with other fires, than can be the case when going direct from an isolated cell to the boiler. It is obvious therefore that, combustion being more perfect, a higher as well as a more regular temperature is attained, and therefore a higher rate of burning.

As the result of careful observation the author has found that the ratio of burning on each grate on a three-grate unit is as 3, 4, and 5. On the grate furthest from the combustion chamber the rate of burning was 35.21 lbs. per sq. ft. of grate area per hr.; on the middle grate, 74.6 lbs., and on the grate next the combustion chamber 89.6 lbs., which gives an average of 73 lbs. per sq. ft. of grate area per hr. over the whole area.

In the cycle of operations which takes place after the delivery of the refuse into the storage bunker there are three distinct stages, in each of which the features embodied in the furnace design play an important part. These stages are:

(1) The charging stage.

(2) The burning stage.

(3) The clinkering stage.

With regard to (1) a storage hopper or bunker is

Until recently the great object of the destructor furnace designer, viz. the maintenance of a uniform and normal ruling temperature in the furnace chamber, could not be attained, the chief difficulty being reached at the third stage in the process of clinkering the fires, when an inrush of cold air inevitably reduces the temperature of the chamber. By an ingenious device it is now possible to automatically and continuously control the conditions determining the efficiency of combustion in the destructor furnace. This apparatus is an entirely new feature in destructor practice, and has been installed on the plant just put to work in New York, and has been an unqualified success.

House refuse ordinarily contains a high percentage of vegetable matter, which consists of upwards of 70% of moisture. Under these circumstances a steam jet as a means of supplying forced draft does not strike one as being as desirable as it would be adding air saturated with steam to an already heavily-charged moist fuel. The better method, therefore, of supplying forced draft or a pressure of air in the ashpit would be by fan. It is eminently desirable, however, that the air should be heated. This can be obtained from the waste gases after leaving the boiler by means of an air-heater addition of about 1 cwt. (112 lbs.) of coal to each ton of refuse.

The ventilation of the destructor house should not be from the inside to the outside, but vice-versa. By this means any objectionable odor which may arise when the refuse is being delivered is not distributed to the surrounding neighborhood, as is the case when the ventilation is from the inside to the outside. The best means of ventilation is by means of an air duct constructed in the roof, communicating with the shaft supplying the air for forced draft for the furnaces. The air is drawn from every part of the house simultaneously, heated and passed through the furnaces, and as the only means of ingress for the fresh air should be at the openings at the ground level, this method ensures that the inside of the building is as fresh as it is possible to be.

Incidentally, the fan thus serves a double purpose, as it extracts the air from the destructor house and affords a good system of ventilation, and also the purpose for which it was originally intended, namely, the supply of forced draft.

Generally speaking, the following are features which should be absolutely insisted upon in any destructor installation:

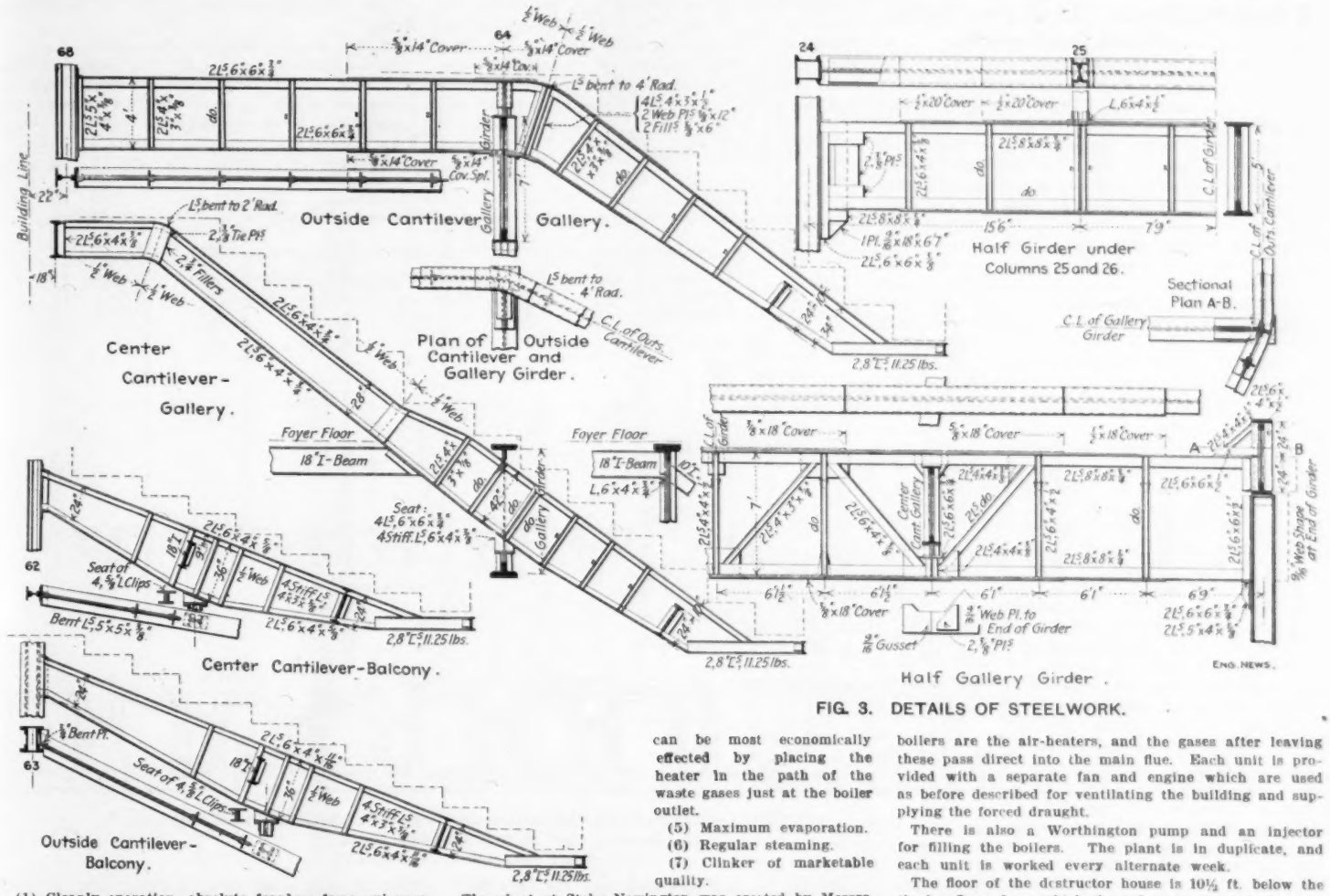



FIG. 3. DETAILS OF STEELWORK.

(1) Cleanly operation, absolute freedom from nuisance to the neighborhood, and maximum comfort for workmen.

(2) Minimum capital cost, consideration being given to the value of the steam and clinker, and general efficiency.

(3) Low maintenance charges combined with low labor cost.

(4) The necessity for heating the air-supply has been more than ever demonstrated in recent years, and this can be most economically effected by placing the heater in the path of the waste gases just at the boiler outlet.

(5) Maximum evaporation.

(6) Regular steaming.

(7) Clinker of marketable quality.

The plant at Stoke Newington was erected by Messrs. Heenan & Froude, Ltd., of Manchester, and consists of two units of three grates each; each grate has an area of 25 sq. ft., and there is a separate ashpit to each grate. At the end of each unit is a large combustion chamber at right angles to the furnace. At right angles to this chamber and parallel with the furnaces are placed two Babcock & Wilcox water-tube boilers, each with a heating surface of 1,741 sq. ft. At the end of the boilers are the air-heaters, and the gases after leaving these pass direct into the main flue. Each unit is provided with a separate fan and engine which are used as before described for ventilating the building and supplying the forced draught.

There is also a Worthington pump and an injector for filling the boilers. The plant is in duplicate, and each unit is worked every alternate week.

The floor of the destructor house is 10½ ft. below the tipping-floor, from which the refuse is shot into hoppers immediately in front of the furnaces.

The furnaces are of the front-feed type—that is, they are fed and clinkered from the same opening.

The average quantity of refuse received at the destructor in the summer is 30 long tons per day, and in the winter 45 tons per day. This is dealt with by two shifts of two men each. The number of hours worked by each shift is eight in the summer and ten in the winter.

During the two years the plant has been in operation there has not been a sufficient use for the steam generated, and the author is therefore unable to give a complete year's working of the results which could be obtained.

At present, beyond the small amount of steam required for the fan and the pump, there is a crusher engine of 15 HP., a disinfecting station, a small electric generating station with a dynamo of 77-KW. capacity, which is worked nightly at a load of 170 amperes and 515 volts, and 22 public slipper baths. The boilers are set to blow off at 100 lbs., and with the bye-pass damper partly open steam is constantly blowing off. During the winter six months, between the hours of 10 a. m. and 2 a. m., 2¼ lbs. of water are evaporated per lb. of refuse, and in the summer about 1½ lb. per lb. of refuse. In the summer work ceases at midnight.

The clinker is used for a large variety of purposes. During the last nine months the author has used some 1,000 (long) tons, which has resulted in a saving of 330£ ($1,600) for ballast and sand.

The clinker has been used for concrete in foundations of walls, retaining walls, floors, roofs, concrete foundations for paved roads, both wood and granite, and also paving yards and footpaths. The divisions between the slipper baths were made of reinforced clinker concrete, 1½-in. thick, at a cost of 3s. 5½d. ($4 cts.) per sq. yd.

The cost for burning the refuse equals 7.3d (14 cents.) per (long) ton. In addition there is the cost of cleaning the flues, amounting to 0.5d per ton. A fitter is employed about the premises, a proportion of whose wages should be charged to the destructor. A boy on each shift is engaged for the purpose of picking out the tins from the refuse, which he pulls forward for the stokers, but this is no charge on the destructor, as the amount received for the tins equals the wages of the boys. The cost of disposing of the clinker in the first year amounted to 196£ ($950) but during the second year there will be no charge for this, as the sales and use to which the clinker has been put will probably result in a profit.

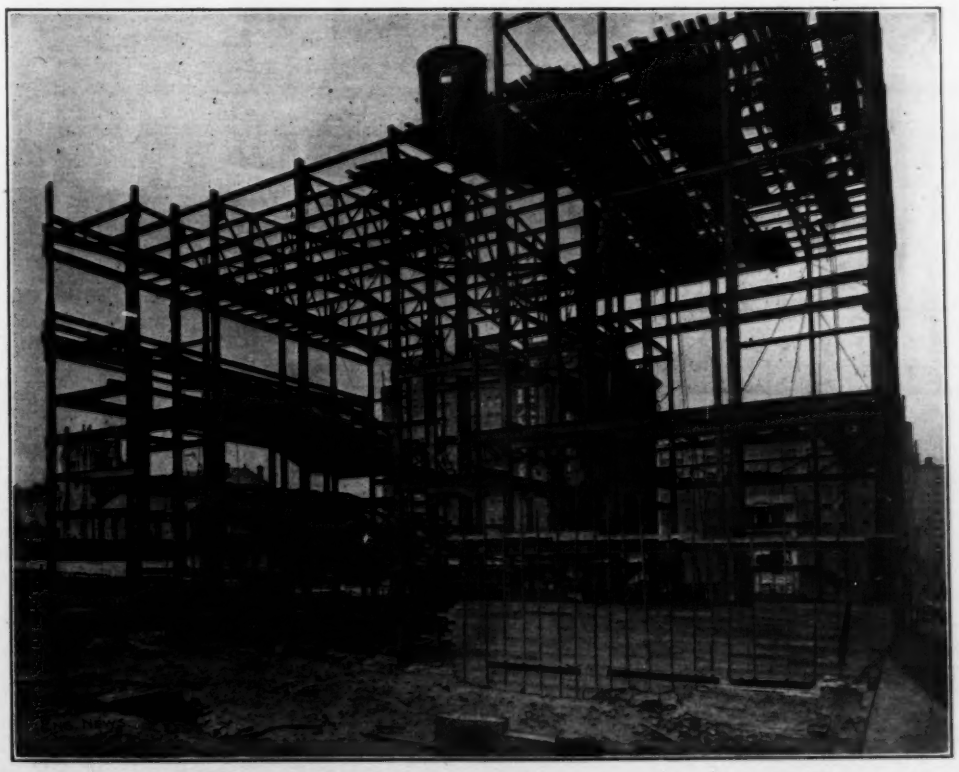


FIG. 4. VIEW OF STEEL FRAMEWORK OF THE COLUMBIA THEATER, SAN FRANCISCO, CAL.

# A Reinforced-Concrete Locomotive Coaling Station of 2,000 Tons Capacity.

By L. M. EWELL.*

Appurtenant to the abolishment of grade crossings in the city of Philadelphia on the Philadelphia, Germantown and Norristown R. R. between Green St. and the Richmond Branch of the Philadelphia and Reading Ry., a reinforced-concrete locomotive coaling station has been recently completed for the latter railway company by the Link-Belt Co. The facilities for serving the locomotives at the Philadelphia terminal of the P. & R. Ry. Co., are such that 700 tons of coal and 250 cu. yds. of ashes are handled per day of ten hours. At present 230 locomotives are dispatched, consuming on an average 500 tons of coal. With the new installation it is apparent that ample provisions have been made for a substantial increase in the number of locomotives before the capacity of the station is taxed materially.

### Description of Pocket.

The coaling station is located in the Green St. yard on the east side of the railroad, north of Spring Garden St. station, at a point which corresponds with Wallace St. Referring to Fig. 1, it is seen that the bottom of the pocket is at the elevation of the elevated structure, which at this point is composed of a fill and retaining walls, about 17 ft. 6 ins. above the street and low level tracks. With a frontage of 46 ft. and extending 101 ft. 6 ins. to the east, the pocket spans seven tracks spaced 14 ft. c. to c. This spacing of tracks was fixed and the clearance of 13 ft. specified, reducing the steel columns to a 12-in. maximum outside of the fireproofing. The columns to fulfill these requirements, are made up of a 15-in. 60-lb. I-beam with a 10-in. 30-lb. channel riveted to each flange. Columns carrying greater loads are further strengthened by 4 × 3 × ⅝ in. angles riveted to the webs of I-beams.

All columns are mounted on grillages which distribute the loads over the column walls extending down to the bottom slab underlying the whole structure. Fig. 8 is a typical detail of the bottom slab distributing the column and column wall loads. The method of computing reinforcing was in accordance with the Philadelphia Building Laws, with $f_s = 16{,}000$ lbs. per sq. in.; $f_c = 600$ lbs. per sq. in., and $\frac{E_s}{E_c} = 12$. A load of 685,825 lbs. is distributed over the 11 × 14-ft. base, requiring the soil to support a load of 4,754 lbs. per sq. ft., including the weight of the slab at 300 lbs. per sq. ft. Test borings showed soil of such nature that a limit of 3.5 tons per sq. ft. was adopted by the railroad.

Of the tracks under the pocket, six are for coaling locomotives, while the seventh, that one next to the elevated structure, is for the removal of ashes.

In the construction of the pocket, 1:2:4 reinforced concrete is used for the walls, partitions and roof, and the floor and its supporting columns are made of steel and fireproofed. The foundations below the neat line are composed of 1:3:5 concrete.

The floor construction consists of five 36-in. built-up steel longitudinal girders, (Fig. 3) each supported by eight steel columns. These girders carry the steel and the concrete girders which support the floor proper. Inserted between each pair of girders over the six coaling tracks, openings are provided for the coaling gates and chutes, which arrangement gives four gates per track, making it unnecessary for more than an

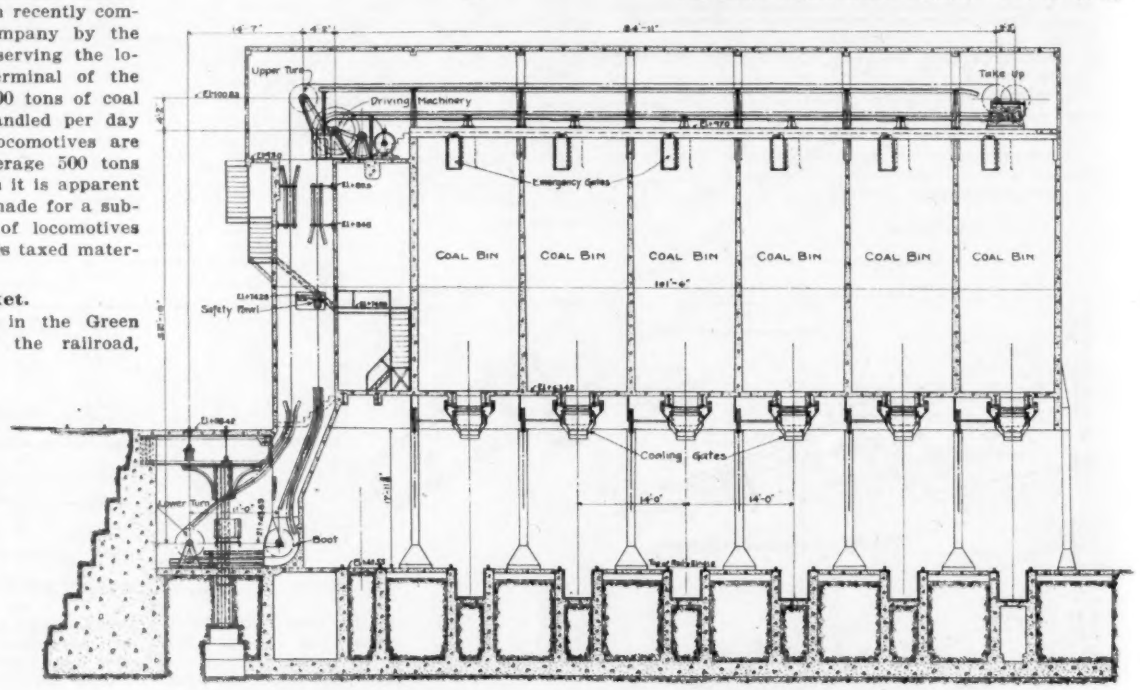



FIG. 1. SECTION THROUGH COAL ELEVATOR OF THE PHILADELPHIA & READING R. R. Showing Path of Coal Handling Outfit.
(Section taken along line FF. of Fig. 4.)

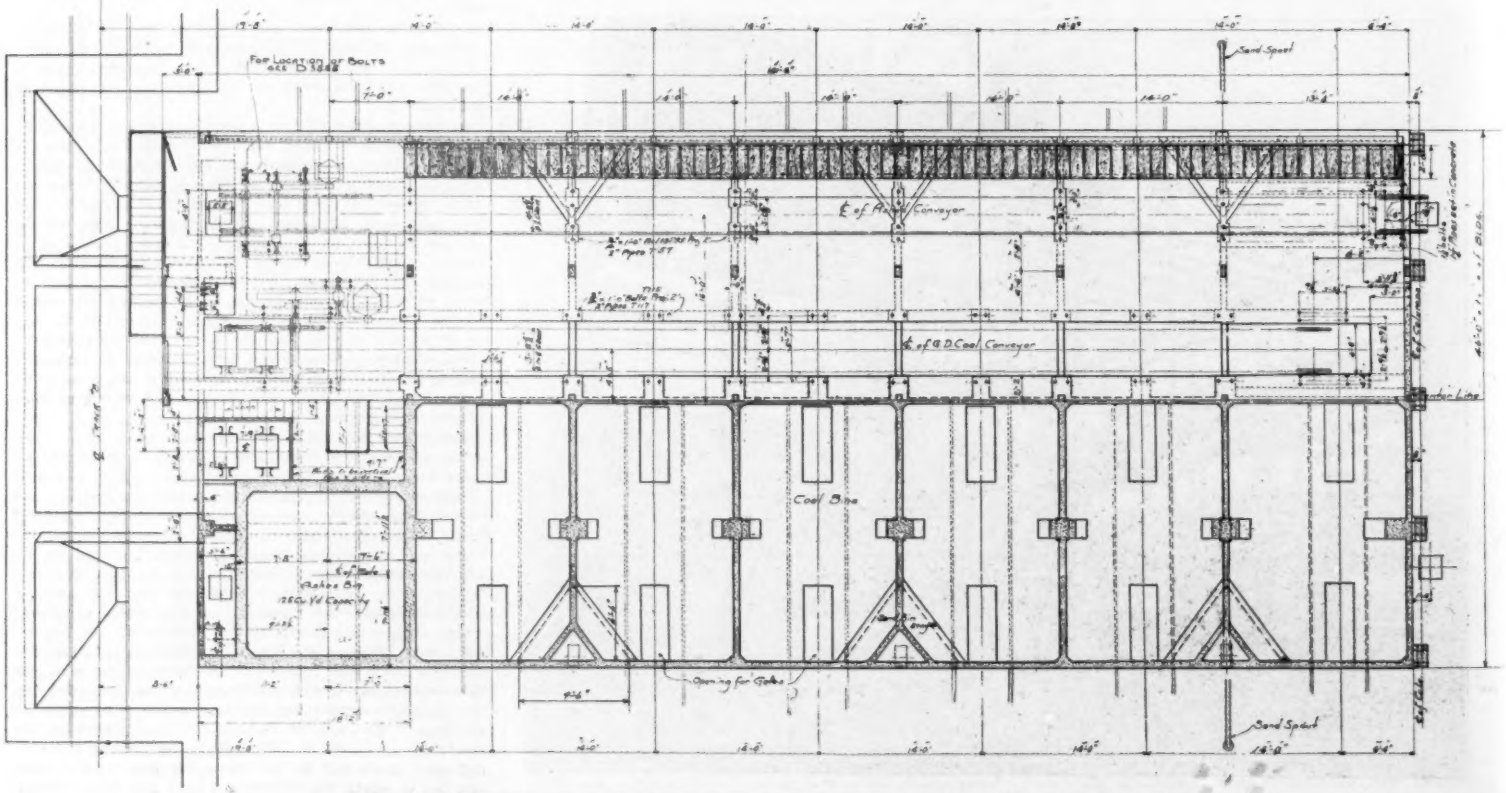



FIG. 2. HALF PLAN OF CONVEYOR FLOOR ON BOTTOM AND OF BIN FLOOR ON TOP.

*Engineer, Link-Belt Co., Nicetown, Philadelphia.

approximate setting of the locomotives to be able to take on coal, and also increases the self-emptying feature of the pocket. The gates are suspended from two 18-in. 60-lb. I-beams which are carried by the longitudinal girders.

The body of the pocket (Fig. 2), from the row of column between tracks 6 and 7 to the east end, is equally divided into twelve bins by one longitudinal and five transverse partitions running the full width of the pocket. These twelve bins are for coal, and each is fitted with two patented, hand operated coaling gates of the balanced apron type. The body is made of cast iron, ¾ in. thick, on which is hinged the geared undercut gate. The apron is made of ¼-in. steel plate, suitably stiffened with angles and is hinged with the undercut gate on the cast-iron body. A live steam line has been installed to thaw out any gates that might be clogged up with frozen coal.

The space included between the transverse partition forming the western end of the coal part, and the west wall, is divided into three parts, two of which are used for the ashes bins, the remaining space being taken up by wells—two for the ascending runs of the ashes carriers, two for the vertical runs of the coal elevators, and the well for the stairway, as shown in Fig. 2. Wells for the ashes carriers extend from the floor of the ash tunnels under the low level tracks, to the machinery room floor over the pocket, admission being gained through door leading from the reciprocating feeder room under the elevator. The coal elevator wells extend from the reciprocating feeder room up through the floor above the pocket. In addition to the opening at the foot of these wells, access to them is had from the stairway, through removable doors. For convenience of inspection, each well contains a ladder. The main entrance to the pocket is from the elevator, the stairway, beginning at this point, goes up around the walls and, between the coal elevator casings, passes through the end of the pocket. Continuing up across the face of this wall, it then leads through an opening in the wall of the superstructure, which, at this end, projects beyond the face of the building to allow ample clearance around the head machinery. To protect the opening in the end wall of the stairway, a sliding door is used.

Sand bins are formed by the branching of three of the transverse walls, and the side walls of the pocket. Each has a capacity of 8 cu. yds. and is fitted with a cast iron outlet from which the telescopic sand spouts are suspended.

In the cross section of the pocket, as shown in Fig. 3, the superstructure floor is carried by the partitions, and does not extend for the full width of the pocket, but only far enough on each side to reach the ashes carriers. A continuous opening is provided in the path of the coal elevators, instead of the short ones that would be required under each discharge gate. This is done to prevent the accumulation of coal under the trough; and to induce the cleaning of the floor by providing the ready means for the disposal of any coal.

Fig. 7 shows the manner in which the side walls were reinforced, the same method being adopted for reinforcing both sides of the transverse walls.

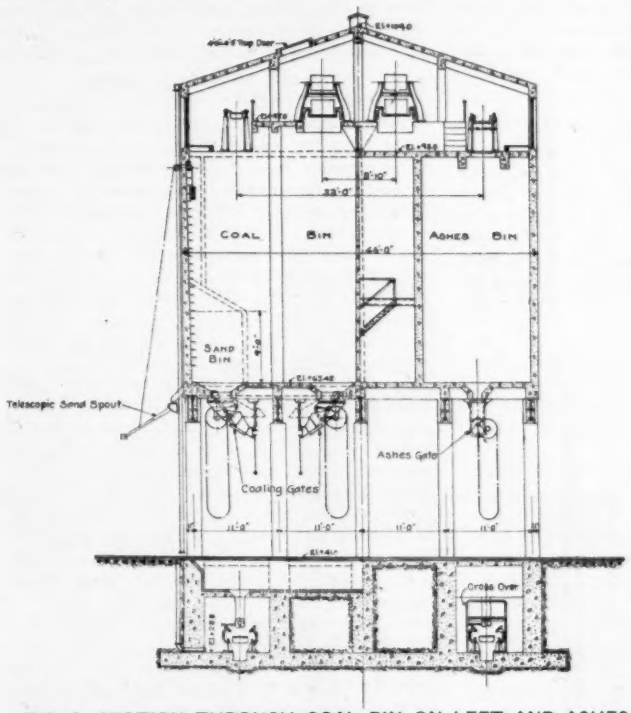



FIG. 3. SECTION THROUGH COAL BIN ON LEFT AND ASHES BIN ON RIGHT.
(Sections DD. and CC. of Fig. 5.)

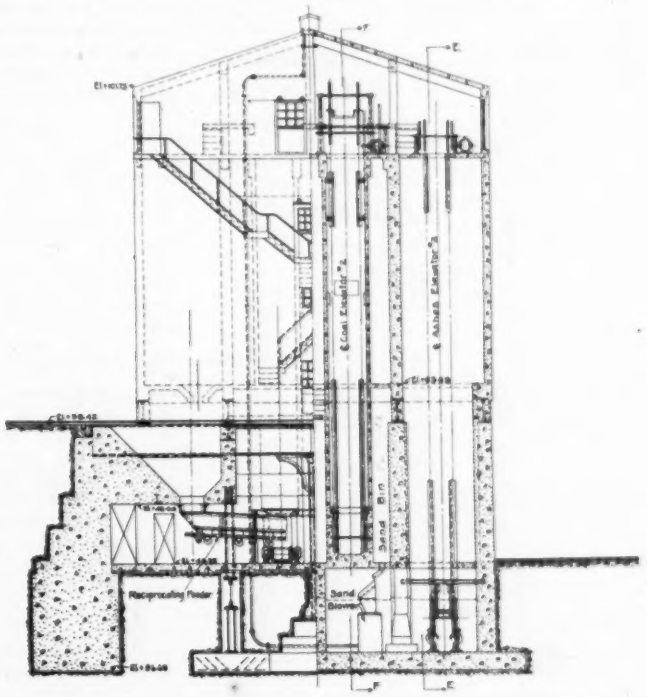



FIG. 4. SECTION THROUGH SUPPLY TRACK ON LEFT AND ASHES AND COAL ELEVATOR ON RIGHT.
(Sections AA. and BB. of Fig. 5.)

### Coal Handling Outfit.

The track hoppers on the supply track are 12 × 15 ft. in plan, and 38 ft. c. to c. (Fig. 1). This spacing admits of two coupled cars dumping without unnecessary shifting. Made of reinforced concrete, each hopper has a level full capacity of 22 tons. To transfer the coal from the hoppers to the coal elevators, a reciprocating feeder is used, as shown in Fig. 4. This feeder is composed of two side plates, and a reciprocating bottom plate. The side plates are made of ¼-in. steel, suspended at one end from the under side of the track hoppers, and supported by cast iron stands at the other end. The bottom plate is made of ½-in. steel, and reciprocates on rollers which are suspended from the side plates. A 5-HP. motor supplies the power for each feeder, motion being imparted to the bottom plate through a variable throw crank and connecting rod. This adjustable feature is very desirable considering the

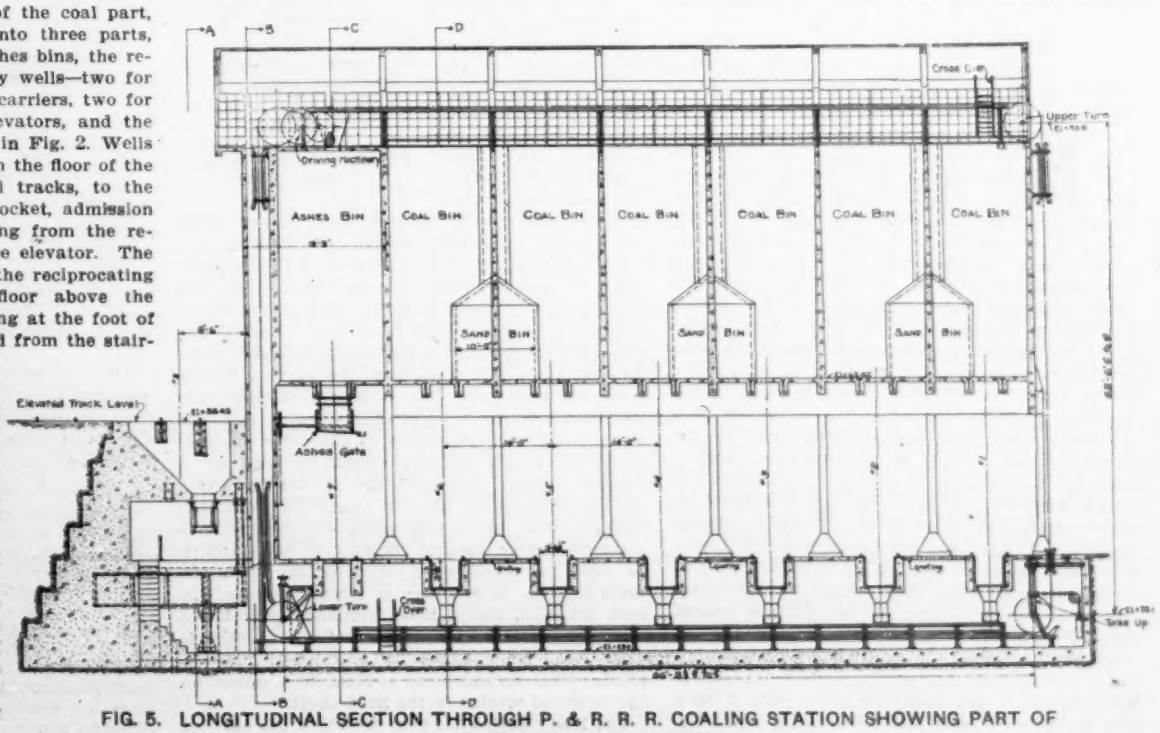



FIG. 5. LONGITUDINAL SECTION THROUGH P. & R. R. R. COALING STATION SHOWING PART OF ASHES HANDLING OUTFIT.
(Section EE. of Fig. 4.)

various sizes of coal to be handled by one machine, viz., run of mine bituminous, egg, buckwheat, and steamboat. The eccentricity can be varied from 3 ins. to 10 ins., making it possible with a full hopper to regulate to a nicety the quantity of coal delivered to the elevators.

Each elevator is composed of a double strand of 3½ × ½-in. steel bushed strap chain, 18 in. pitch,

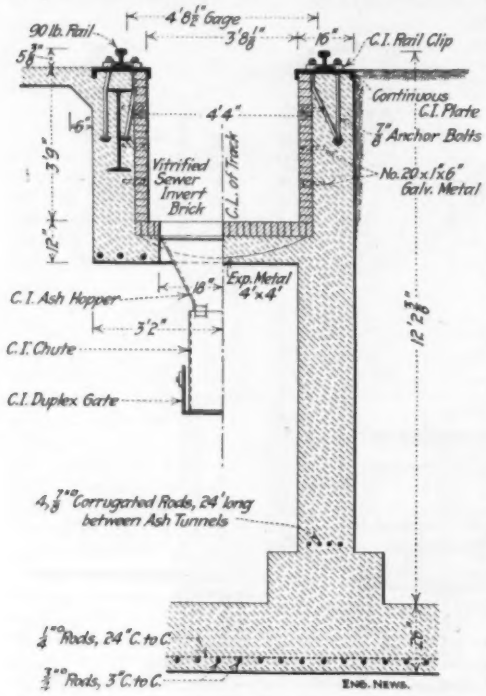



Fig. 6. Half Section Through Track Over Ash Tunnel.

with 7 in. diameter, 4 in. face, chambered rollers at the points of articulation. The speed of the chains is 75 ft. per min., and with a 12 × 24 in., ¼-in steel bucket, 36 ins. long, spaced 3 ft. apart, will carry 100 tons per hour, a 25-HP. motor for each elevator supplying the necessary power. The driving machinery for each is located in the superstructure, at the head of the ascending runs. It is supported by cast iron frames, making a compact arrangement, at the same time one by which all gears are accessible. Where so unprotected as to require it, gearing is encased and further protected by hand railings.

The construction of the trough on the horizontal run over the coal bins is worth noting, being composed, as it is, of cast iron throughout, including the turn at the head shaft, the sides, bottom, and discharge gates for the entire run of about 100 ft., making it one of the very few machines of this class in which cast iron is so extensively used. With this construction the machines are better able to resist the destructive effects of the acidulous water in washery buckwheat coals, and the gases that are to be found around coaling stations, which are to be seriously considered. One cannot be more impressed by such destruction than by actually seeing steel which has been exposed to their action; where the webs of girders were so eaten away as to admit of a person crawling through them, bracing rusted to mere threads, this being the condition of a coaling station that has recently come to the writer's notice. Fig. 3 shows how the trough is made up, the sides being cast in 7 ft. lengths, the bottom as dished plates 21-ins. long, and 5 × ⅜-in. flat steel wearing strips for the rollers, in lengths of 26 ft. These parts are easily handled, represent a saving in the cost of erection, and tend to localize any damage that might be sustained. Floor stands supporting the trough are spaced every 7 ft., every other one being high enough to carry the tracks for the return run of chain.

A discharge gate is placed over each bin, and is composed of a flat cast-iron plate with a rack cast on the under side, the whole being supported by flanged rollers running on 30-lb. T-rails. A shaft running under the trough in advance of the gate opening, turns a pinion whose teeth engage those of the rack, sliding the gate back to any amount of discharge opening.

The short length of horizontal run of the coal elevators in the reciprocating feeder room at the loading point, is of the same general construction as that of the other horizontal run, a steel bottom plate backed up with planking being substituted for the cast iron plate to withstand the rough treatment to which it is subjected by the falling coal. Where the buckets pass from this run to the vertical position, a boot has been swept out of the concrete.

### Ash Handling Outfit.

The six coaling tracks (Fig. 5) have trenches between the rails for receiving the ashes deposited by the locomotives. As shown in Figs. 2 and 6, these trenches are 3 ft. 8 ins. wide and 3 ft. 9 ins. deep with sides and bottom lined with a hard brick and run for the full width of the pocket, the sides of the trenches forming the girders for supporting the track as indicated. The rails are not laid directly upon the concrete, but upon a cast-iron plate which runs continuously along the top of the trench sides. Anchor bolts pass through the plate, and bevel washers hold the rails in place. Where the tracks cross the ash tunnels, the girder section shown was adopted, the 24-in., 80-lb. beams carrying the entire load, the reinforcing bars being used for supporting and confining the concrete below. The tracks between the ash tunnels are supported by the walls which rest upon the bottom slab. An opening in the bottom at each end of the trenches is fitted with a cast-iron hopper and duplex gates. Ashes are scraped to either end and upon opening the gates in the bottom of the hopper, they fall into the ashes carrier in the tunnel below.

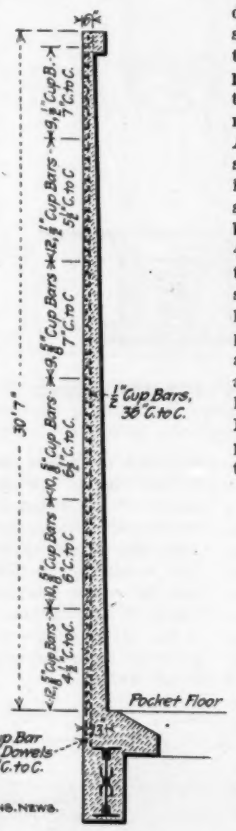

6"
9, ⅝" Cup B. 7" C. to C.
9, ⅝" Cup Bars 5½" C. to C.
12, ⅝" Cup Bars 6" C. to C.
10, ⅝" Cup Bars 6½" C. to C.
10, ⅝" Cup Bars 4⅛" C. to C.
30'1"
1½" Cup Bars, 36" C. to C.
Pocket Floor
23"
3" Cup Bar Dowels 12" C. to C.
ENG. NEWS.

Fig. 7. Section Through Outside Wall.

These ashes carriers are of the pivoted over-lapping bucket type known as the Peck carrier. Composed of malleable iron, 24 × 24 in. buckets are suspended on a cross rod between two strands of 24 in. pitch malleable iron, steel bushed chain. Each has a capacity of 20 tons per hour running at the slow speed of 20 ft. per min. Their paths are rectangular ones, passing under the ash trenches, the buckets go up at the west end of the pocket, over the ashes bins, each bucket discharging its load by a stationary dumper. Continuing across the coal bins, the carriers return down the east wall. The driving machinery units are placed at the head of the ascending run, and are similar in construction to those for the coal elevators, power being supplied for each by a 7½-HP. motor. Each of the driving sprockets on the head shaft has an equalizing gear, the rims of both being removable and bolted to a common center casting, making it unnecessary to scrap a whole gear or sprocket when the teeth become so worn as to require repairs. In each machine, one of these combined gear drives is keyed to the head shaft while the other is loose, both being driven by a common countershaft. This arrangement reduces to a minimum the torsional strains in the head shaft.

The lower horizontal run, on which the carriers are loaded, is fitted with continuous cast iron guards which allow the buckets to be overloaded at the hoppers due to the sudden rush of ashes, but at the turn wheel, where the buckets pass from the horizontal to the vertical run, a leveler is installed to trim the buckets, thus insuring the clean unlapping of the buckets at this point. The ashes guard and the 30-lb. T-rails carrying the chain are supported at intervals by cast iron stands securely bolted to the floor of the tunnels. The upper horizontal run is similarly supported, the stands being spaced 14 ft. apart in order to be located on the partitions.

### Sand Handling Outfit.

The sand handling machinery consists of a blower located under the sand hopper that is filled from the supply track on the elevated, and the necessary piping to the various sand bins in the side of the pocket. The blower is of the type ordinarily used by railroads, composed of a tank fitted with an air controlled inlet valve for the sand, and a funnel shaped outlet for the sand and air. The air pressure pipe is led into the blower and ends short of the funnel, which is located near the bottom. When in operation, the sand is drawn in the outlet pipe, giving a continuous stream. With a pressure of 70 lbs. per sq. in. the sand is elevated in the two inch discharge pipe for a height of about 75 ft. At this point the pipe makes a right angle bend of about 5 ft. radius and continues horizontally about 60 ft. At the bend an additional supply of air under the same pressure is applied. The air is discharged into the dome located on the roof, where the sand separates from the air and, falling to the bottom, flows by gravity to the sand bins through 4-in. pipes, an angle of 35° being preserved throughout this part of the line. Each sand bin is fitted with a cast-iron outlet on which the telescopic spouts are supported. These spouts are of the design adopted by the N. Y. C. & H. R. R. R., for use at their two new coaling stations, one at Rensselaer, N. Y., and the other at Suspension Bridge, N. Y. Being counterweighted, they are quickly placed in position for loading and as quickly returned to the idle position.

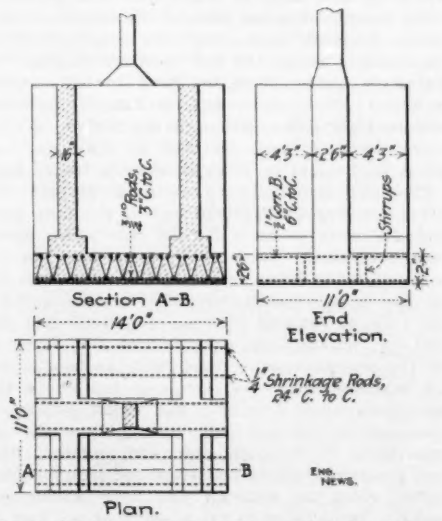



Fig. 8. Detail of Typical Base of Interior Column.

The contract for the coaling station was awarded to the Link Belt Co. The J. M. Dodge Co. designed and constructed the building and its foundations, while the equipment was designed and installed by the Link Belt Co.

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CLINKERING FINE IRON ORE IN ROTARY KILNS is practiced at the Fernie Works at Giessen, Germany, and is reported to be successful, as stated in "Stahl und Eisen" of May 4, 1910. The kiln used is 115 ft. long by 8 ft. in diameter, and is fired with coal-dust. It was found necessary to maintain careful control of the maximum temperature, so as to get incipient fusion of the dirt while avoiding any reduction of the iron and manganese oxide. The ore in question contains (air-dried) about 22% Fe and 21% Mn. As mined it carries 20 to 30% water, which is completely removed by the clinkering process. It is said the process has been patented.

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New hope for the Appalachian Forest Bill has been awakened by the action of the rules committee of the House of Representatives, which has made possible the passage of the bill by the House at the present session of Congress. The bill is designed to aid in the preservation of the rapidly-disappearing forests of the White Mountains in New Hampshire, and of the Southern Appalachians as well. If friends of forestry and conservation let their representatives in Congress hear from them there seems to be good reason to believe that both the House and the Senate will pass the bill before Congress adjourns.

The added demands upon many of our readers caused by the ever-increasing number of technical societies lends interest to almost any proposal to diminish the number of such organizations, even though one may not be directly concerned in the matter. On this account, as also because of its direct interest to many of our readers, we call attention to the discussion of the proposal to consolidate the Master Car Builders' Association with the Master Mechanics' Association, reported at some length elsewhere in this issue. Our own comment on the proposal is made in connection with our report of the discussion.

The desire to accomplish record-breaking feats and the eagerness of the daily press to record such is responsible for many ridiculous reports of old records broken and new ones established. The big trans-Atlantic liners and their newspaper friends "held the record" for such records until recently, but they have recently been outclassed by the aeronauts and their newspaper allies and backers. As an example we quote from a New York daily:

> Hamilton established two new world's records and one American record. His was the first flight, in the history of aviators, ever made in a heavier-than-air machine in which the aviator has flown across country between two large centers of population in both directions in one day. The second world's record, the most remarkable ever achieved, is that Hamilton flew a distance of 86 miles exactly on schedule time.
> The flight is also the longest cross-country flight ever made in the United States and is surpassed by only two in the world.

Bearing in mind the much advertised "sang froid" of the intrepid aviators, manifested, on landing from such trips, in an insatiable desire for a certain combination of rice paper and tobacco, we expect to hear next of such remarkable aerial performances as "miles per hour with cigarettes," or "maximum height of ascent with a dark Havana."

After twenty years of blundering with furnaces poorly adapted to their task, American cities are beginning to adopt refuse destructors of the latest improved British type. Elsewhere in this issue we print a brief but clearly-put summary of the essential features and principles of refuse-destructor design. The article requires little editorial summary or comment. We call attention to its value to American engineers and city officials, to the stress it lays on providing for the comfort of workmen employed at refuse destructors, including remarks on ventilation, and to the assurance of the author that city refuse can be made to burn itself, instead of requiring extra fuel, and to provide excess heat for commercial purposes. In this connection the author writes of heating air for forced draft, and says that the practice increases the heat production of the furnace by an equivalent of 100 lbs. of coal *added* to each ton of refuse burned. Until quite recently an American engineer would value any improvement in a garbage furnace in terms of coal or other fuel *saved*.

It is particularly interesting to see a reference to a refuse destructor in New York City by way of illustration of a recent important advance in destructor design and operation.

The article is not wholly a summary of principles. It concludes with a brief description of a recent installation at Stoke Newington, England. It is significant that even in England, where the utilization of heat from refuse destructors has been carried so far, not all the heat available at Stoke Newington had been marketed after the plant had been in operation two years. It remains to be seen whether American cities will be able to sell or themselves utilize the heat from high-temperature destructors. If not, it may be economically advisable to materially modify the most advanced type of British refuse destructor to suit American conditions, or to evolve a distinctly American type.

A commendable piece of work on the part of the Health Department of Chicago is the publication in its weekly bulletin of an offer to supply prospective vacation takers with information regarding the sanitary status of 34 named Michigan summer resorts. Equally commendable is the work of the Michigan State Board of Health in collecting the information thus offered and in making it available to the health authorities of Chicago. It is hoped that similar information for places in Wisconsin will soon be available. Years ago a board of health in one of the popular seaside resorts of New Jersey made available to prospective visitors information regarding the sanitary status of local boarding houses, etc. Besides the protection afforded by making such information readily available, the procedure is bound to have a salutary effect upon those responsible for the sanitary conditions thus laid open to the public.

The physical valuation of railway, waterworks, lighting and other properties owned by public-service corporations is becoming more and more common. Such valuations raise many important questions, most of which come before the engineer. Some of the general principles involved were discussed at length in the article on the Appleton Water-Works Case, before the Wisconsin Railroad Commission, published in our issue of June 16. Most of the article is devoted to extracts from a report of the engineers to the Board, and the extracts deal with physical valuations.

One of the most important phases of a physical valuation is the basis to be adopted for determining the unit prices to be used in computing reproduction values. The unfairness that may result, sometimes to the public and sometimes to the private company, through taking the current price of the moment for valuation purposes is forcibly set forth in the article mentioned in the preceding paragraph. The point of the argument is enforced by a diagram, unfortunately omitted from publication with the article, which we show on p. 733 of this issue.

## The Effect of Recent Engineering Progress in Reducing the Value of Water-Power.

The question "What is the value of water-power?" may seem at first sight to be a threadbare one. For a quarter-century, and even longer, engineering literature has been well supplied with papers in which experts have discussed from various points of view the value of water-power under various circumstances. It seems to us, however, that, by the public at least and probably by a large part of the engineering profession as well, there is not sufficient appreciation of the effect which recent developments in mechanical engineering have had upon the value of water-powers. The value of undeveloped water-powers is to-day much less than it was 15 or 20 years ago. The cause of this decrease in value of water-power is the great reduction in the cost for which power can now be developed by other prime movers.

This fact is one of great public importance, and one on which the public ought to be informed. There never has been a time when the development of water-power has been more prominent than at the present time. It is one of the most important features of the so-called conservation movement. The claim is made that the undeveloped water-powers which are still owned by the states or the nation are of such vast value that they should not be allowed to pass into private hands in perpetuity, but should be leased under reasonable restrictions, and the title to them should be retained by the public.

We have in the past expressed general agreement with this view, which is held, we believe, by many members of the engineering profession; but it ought to be understood that the importance of public control of water-power is in the distant future rather than in the present. It ought to be more clearly understood that in most locations and under most circumstances it is exceedingly difficult to develop water-power and make a good profit on the capital invested. Any public revenue derived from water-powers will have to be merely nominal for many years to come, or their development will be greatly hampered.

Again, it is important that investors should know the real situation with reference to water-power values. The prevalent idea appears to be that the development of a water-power is a process of obtaining something of value from Nature without paying for it. The average investor contrasts the fact that with a steam plant, coal must be steadily fed under the boilers and paid for at so much a ton, while with a water-power plant the natural flow of the stream constantly turns the wheels. He concludes, therefore, that water-power is necessarily cheaper than steam-power. He has no understanding of the other elements which affect the problem and which extremely often reverse the comparison.

The public belief in the great value of water-power has been made the basis of a great state enterprise, and it is even proposed that the nation shall become concerned in great water-power development schemes. The State of Illinois has voted $20,000,000 for the creation of a deep waterway from Chicago toward the Mississippi River, and the voters have been given to understand that the water-power incidentally developed by the construction of the waterway will be so valuable that it alone will repay the cost of the work. The promoters of great schemes for inland waterways have as one of the stock arguments in their campaign the claim that the great value of the water-power incidentally de-

veloped will repay to the public a large part of the cost.

Still again, knowledge as to the true value of water-power is of great public importance from quite a different point of view. Cities throughout the country, great and small, are engaged in the increase of their water-supplies. In many cases it becomes necessary in this work to reduce the flow in a stream which has been used or may be used for power development. The value of water-power in such cases becomes often a matter which must be settled by litigation. If the values frequently adopted in compensating the owners of these water-powers were the true values, then indeed all the glowing claims of the water-power promoters' prospectuses would be justified, as would all the claims of those who urge the extremest doctrines of conservation. In our opinion, however, most of the awards for damages in water-power cases are much beyond the actual value of the plants which are taken.

We have made the above brief review to show in some degree the importance of correct knowledge as to the value of water-powers. Let us turn now and see what some of the recent developments have been in the field of mechanical engineering, which have so affected the value of water-power. It is common knowledge that the development of electric power transmission some 20 years ago gave a great impetus to water-power development, and made available many powers which had hitherto been practically worthless.

Before the days of electric transmission, it was only possible to make use of water-power by locating the factory close beside the waterfall. In the early days of the manufacturing era, the period from 1810 to 1860, for example, this was actually done, and it was because of their water-power that such cities as Lawrence, Lowell and Paterson became great manufacturing centers. About the middle of the last century, however, the steam-engine became developed to a point where it was no longer profitable to place a factory beside a waterfall merely because of cheap power. Convenience of transportation and the supply of materials and labor were of far more importance to the success of a manufacturing enterprise. From 1860 to 1890, therefore, the development of water-power was practically confined to small powers for driving local sawmills and gristmills. All the large work in power development was done with the steam engine.

In the late '80's, however, a new and enormous demand for power arose for the generation of electricity. Shortly afterward came the development of electric power transmission over long distances, which was first exhibited to the world on a large scale by the Lauffen-Frankfort transmission in Germany. It then became possible to develop power at the waterfall, carry it over wires to any desired distance, and there distribute it as electric current for lighting or railway purposes or turn it again into power for driving factories.

During the 15 years from 1890 to 1905, long-distance transmission enterprises were carried out all over the world. Many of them attained a great commercial success, particularly those which were located in regions where fuel was high-priced. Experience has now placed the long-distance transmission of electricity on a definite basis. Voltages of 100,000 to 110,000 volts are used with as great reliability and success as 10,000 volts was in the early days of the transmission lines. With this experience, however, there has come a clear understanding of the difficulties and limitations in connection with hydro-electric plants and their transmission lines, and these limitations must be borne clearly in mind if one would have a fair understanding of the value of water-powers at the present day.

While the electricians have been busy with long-distance transmission, and the hydraulic engineers with water-wheels, development has been going on in other prime movers. The steam turbine, on the one hand, and the internal-combustion engine on the other are the two machines which have well-nigh revolutionized the field of power development in the short score of years since long-distance transmission brought water-powers again into active development.

The steam turbine is indeed not new historically; it is one of the oldest forms of prime mover. But in its very recent development, it is demonstrating itself to be almost certainly the motor of the future. As first developed, the steam turbine was not highly economical as a heat-engine. It had the great merit, however, of keeping up its economy over a large range of loads. This merit it has retained while its improvement and development have been going on, and this improvement has been so great that the steam turbine of 1910 stands in a very different position from the turbine of ten years or even five years ago. In Chicago last year, steam turbines of 5,000 KW., installed only six years ago, were removed and replaced by turbines of 12,000 KW. The fuel economy of the new turbines, compared with the old, was sufficient to pay good interest on the cost of making the change. In one of the great electric stations in New York City, a combined plant of steam engines and low-pressure turbines is in use, which was described by Mr. H. G. Stott in our issue of March 10. This plant shows an average steam consumption of less than 14 lbs. per KW.-hr.

A brief computation will show that such steam economy as this makes the cost of coal a comparatively small element in the yearly power bill. If we assume a plant using power 300 days in the year for 10 hours per day, at the rate of steam consumption just noted, and assume an evaporation of 8 lbs. of steam per pound of coal, we have a fuel consumption per kilowatt per year of only 2⅝ tons. At $2 per ton, this means a fuel bill per KW. per year of only $5.25. Even in the locations where fuel is high-priced, costing as much as $5 per ton, this means only $13.25 per KW. per annum for coal. Fuel cost is only one element in the cost of power production. The cost of attendance is one of the heaviest items. The steam turbine has had an important influence in reducing these costs, because of the small attention which it requires and because of the very large-sized units in which it is built. For the largest-sized power stations, units of 12 to 15 thousand kilowatts capacity are now installed. Such huge machines require little more attendance than machines of a third or a fifth their capacity, and the cost of attendance per power unit developed is correspondingly reduced.

Another great advantage of the steam turbine over all other commercial prime movers is the great reduction in the cost of the generator. The generators built for direct connection to steam turbines have an enormous output in proportion to their weight and cost, and, with the latest appliances for control and operation, are as rugged and reliable as the old type of slow-speed engine-driven generator.

While improvements in turbines and generators have been going on, there have also been great improvements in the boilers for power-house work. The size of units has been increased here also. Economy has been looked after, superheating has been introduced, progress has been made in smokeless combustion and automatic stoking; but most important of all, probably, is the ability to carry overloads. And it is at just this point that the steam-power station shows to greatest advantage in comparison with the hydro-electric plant. In nearly all power-plant service, the operating engineer seeks first of all for ability to carry "the peak of the load." The capacity of the station must be figured, not on the average demand for its power throughout the 24 hours, but for what it can do when the rush hour of traffic on an electric railway or the use of current for lighting makes the maximum demand upon its machinery.

The water-power plant, because of the inherent limitations of its machinery, can carry only a small percentage above its normal rating. The steam electric station, on the other hand, is frequently designed to carry, for a short time, loads 50, 75 or even 100% greater than those for which it is normally designed. In this respect, particularly, the recent development of the steam-boiler and furnaces has been important in enabling the steam station to meet satisfactorily this modern demand for sudden increments of power.

The advantages which we have been enumerating, of the steam-turbine electric station over the hydro-electric station, are translatable into terms of cost. As those of our readers who are familiar with the matter we are discussing are aware, the best designed steam-electric stations, carrying a railway load and working under ordinarily favorable conditions as to fuel supply, are able to develop power for an operating cost, including all repairs, of from ½-ct. to ¾-ct. per KW.-hr. This is done with coal costing $2 to $3 per ton. Stations located where fuel is still cheaper than this are able to do even better.

A brief computation shows that for a uniform load of 3,000 hours per year, ½-ct. per KW.-hr. would be equivalent to $15 per KW.-annum. This price per kilowatt for steam-power is based, however, on the very variable loading of electric-railway service. Water-power stations do not sell their power in that way. They base their cost on uniform loading alone, or rather on the maximum demand, and the user has to pay throughout the whole 24 hours at the rate of consumption which he may have to adopt during the 15 minutes or so of heaviest load.

It may be argued, however, that in the comparisons we have been making thus far, the reference has been to the large-sized stations, where power-developing machines of greatest size can be installed together with the appliances for securing greatest economy. It may be asked how the case stands for the small-sized powers, such as those which are commonly met with in the condemnation of water-powers by reason of the development of city water-supplies. Admittedly, such small water-powers, when advantageously located, are often worth a greater sum per horse-power than the powers of great size which, if developed at all, must be developed in competition with the large steam-power stations. Take, for example, a factory requiring only 100 to 500 HP. If that is developed from steam, a very considerable expense must be incurred for operation, in comparison with the steam-power plant of large size. The expense of engine runner, firemen, boiler inspection, insurance, and various other items, must be met, and, in addition, in a small-sized plant like this it is not possible to secure anything like the economy obtainable in a plant of large size.

Here, however, a new rival has arisen to compete with the waterfall and the turbine. This new rival is the internal-combustion engine. Already the internal-combustion engine can boast a larger number of users than any other prime mover whatever. For small powers, the gasolene engine has practically rendered the steam-engine obsolete. For larger powers, the oil engine and the gas-engine using producer gas are rapidly gaining in popular favor. The fuel economy of such engines is so excellent that the total cost of fuel per horse-power per annum is cut down to a figure nearly as low as that which we have quoted above for the highest-class steam-power plants. The smaller sizes of such engines are run often with almost as little attendance as an electric motor or a water-wheel. Thus the owner of a small water-power privilege must meet the competition of these comparatively new forms of prime movers, in considering what price his water-power is fairly worth.

In what we have been discussing thus far, we have been speaking chiefly of the value of undeveloped water-power. It ought to be said in addition that the cost of developing water-power is very commonly underestimated by the lay public. The old-time development of water-power on a small scale for the sawmill or the grist-mill was comparatively inexpensive, but was correspondingly inefficient and liable to injury by flood. For a really substantial and reliable development of water-power on either a small or a large scale, with proper provision against damage or interruption by floods, and with storage to provide for seasons of low water, it will be found that the cost of water-power development per kilowatt or per horse-power will almost always be largely in excess of the

cost of installation of a steam- or gas-power plant of similar size. This additional investment cost creates an interest charge, which will often offset or more than offset the cost of the fuel for the competing plant.

Nor is the case against the water-power plant all summed up in the above. There are in the steam-power plant waste products in the form of heat, which is often necessary for use in manufacturing processes and must always be supplied, to a greater or less extent anyway, in winter weather. The water-power plant must be debited with this necessary fuel cost in order to compare it with its competitors on an equal basis.

We have already shown that in nearly all cases where water-power is developed on a large scale, the power must be electrically transmitted over long distances, from a few miles to a hundred or even two hundred, in order to reach a market. Such long lines of wire, experience has shown, are more or less subject to accidents, and consequent interruption of the service. So well is this understood that it is becoming a very generally accepted principle that an auxiliary steam plant for emergency service is a necessary part of any successful hydro-electric installation relying on long-distance transmission. That is to say, besides the cost of the water-power development, the long-distance transmission line and the sub-stations for distributing the electric current in the city where it is marketed, steam-power stations must be built in the city supplied and these stations must be ready at all times for an emergency. Such steam stations are generally made use of also to help the water-power plant carry the peak of the load. It must be understood that the cost of operating steam stations on such service is exceedingly high for the power developed. The capacity of such a station must be equal to the maximum demand for power, or else some of the customers must be cut off when any accident cuts off the supply from the water-power plant.

Space does not permit any fuller review of the difficulties and limiting conditions which must be met in the development of water-power plants. We believe these difficulties ought to be more clearly understood by investors and by the general public. Because of ignorance as to these matters, engineers engaged in water-power development are often unjustly blamed for the financial failure of an enterprise; or if they make a success, they fail to receive the credit which should be given them.

It ought to be apparent also that good engineering is a prime necessity if success is to be attained in any water-power enterprise. It takes an engineer of ability and experience to determine beforehand whether a water-power project can be made a profitable enterprise. It takes an equally good engineer to so carry out the work that profits may actually be secured.

## LETTERS TO THE EDITOR.

### College Degrees for Engineering Students.

Sir: It is stated that the subject of the proper degree to give for the completion of an engineering course will come up for discussion at the coming meeting of the Society for the Promotion of Engineering Education. It is certainly time the matter was settled and some uniformity was reached by the schools. At present some of the professors think the graduate should receive a bachelor degree while some think there should be granted the so-called "professional" degree of engineer with some word affixed to designate the specialty.

The professional (?) degree is a joke. It is a strange thing for wise men to try and perpetuate. No school, other than the school of experience, can make an engineer of a man. When a man practices as a civil engineer he will designate himself as being one and likewise with the mechanical, electrical or mining engineer. The abbreviations of C. E., M. E., E. E., etc., are convenient and are often used simply for convenience. They are commonly assumed by men who never saw the inside of a technical school and whose right to assume the title is based on the ability to survey a fence line or a drainage ditch. The thing is of so common an occurrence that the possession of the college-given right to assume the title is little valued by men who have so obtained it.

It is found from definitions in dictionaries and encyclopedias that "bachelor" was a term designating a young man who had made his first step towards knighthood, having graduated from the position of a page while not yet a knight. Later, the term came to mean a young man who had served some sort of apprenticeship in an art and who was ready to start out in life to obtain higher rewards. In this respect the bachelor, in his class, was about on a par with the young journeyman who had finished an apprenticeship in some trade and was starting on his "wanderjahr," to return a master workman. The granting of the degree of bachelor in colleges is of old standing, meaning simply a young man who had prepared himself to attempt to practice the profession of teaching, or literature, or law, etc. The term "master" really meant a teacher and was granted when a young bachelor had gained sufficient experience to warrant his Alma Mater in stamping upon him her seal of approval and recommending him as a teacher. The term of "doctor" meant a learned man, also a teacher, but a grade higher than a master.

In such a scheme there was and can be, no arrangement for the term "engineer," for the root form of the word indicates that he is "the ingenious one." His designation can hardly properly be twisted into a title, representing a degree. It was a strange thing that a common name used by all men professing to follow the vocation of engineer, should be taken up by the schools and made an academic degree and title. Inasmuch as the title is often assumed by the ignorant and pretentious man and often conferred on men by friends, as a bit of flattery, it should really be dropped as a degree given in course.

The degree of "Bachelor of Science in Civil Engineering" is awkward, for no man who uses it really gives the right impression. Written as it often is, B. S., C. E., it gives the impression that the man holding it has pursued a scientific course as well as the civil engineering course. To give the degree of Bachelor of Science above is hardly enough for the science course in many colleges is a joke among the students and a great many men take that degree because the course is so easy. Even considering that the degree of bachelor of science is hardly proper, it becomes silly when it is taken into consideration that a great many schools regard the professional degree as the equivalent of the bachelor degree while others place it on an equality with the masters degree. Something should be done to stop the confusion.

Why cannot all schools unite on the proposition of giving a degree in engineering, precisely as a general science degree is given or one in literature, or in music, in arts, etc.? The faculties should get together and agree that hereafter the degree for a course in civil engineering will be B. C. E.; for mechanical engineering, B. M. E.; for electrical engineering, B. E. E., etc. The degree for the course in mining engineering will of course be the same as that for the mechanical engineering course so far as the use of the letters is considered, but that can hardly be helped. The man who receives the degree will designate it by letters and not spell the names in full. Let the degree of master be abolished for the word is not used to-day in exactly the sense it formerly had, and to style a man as Master of Civil Engineering, for instance, would submit him to ridicule. However, the professional degree might be given by colleges in much the same way the degree of Master of Arts was formerly conferred. After a man had been long enough out of school to have fulfilled the requirements for becoming an Associate Member of the national engineering societies the school might confer the degree upon him if he desires it and will pay a small fee and submit some sort of a thesis. The degree then will be a title never conferred in course, but given to a man as a reward for recognized service in his chosen profession. The many who leave the profession after graduation will then not have the higher degree. It can become a degree to be given as an honorary degree to deserving men who have not graduated but who are otherwise entitled to be ranked as engineers. It would be equal to the Master's degree.

For men who return to school to pursue higher studies, or for men who have become particularly eminent there should be given the degree of Doctor of Engineering, there being no designation of the specialty. The degree would then mark a man learned or eminent in engineering. As an honorary degree it should not be granted to any man under the age of fifty years. As a degree given for studies pursued at college it should be given only to men who have earned the right to the professional degree and who have also pursued at least three years' study or research, somewhat as the degree of Doctor of Philosophy is now granted.

Whatever is done, we should certainly stop the giving of the degree of engineer to beardless boys, who have had little or no experience, simply because they have pursued an engineering course in an engineering school. We should also stop the giving of such a degree as a first, or bachelor, degree in one school and in another school a few miles away having it considered the equal of a master's degree. Such absurdities make the engineer ridiculous. Is the Society for the Promotion of Engineering Education supplied with enough backbone to settle this matter or will they fail to come to an agreement and again give cause for the perversion, "Society for the Prevention of Engineering Education."

Yours truly,

"A Civil Engineer."

Chicago, Ill, June 2, 1910.

### Credit for Design and Construction of Albemarle Sound Crossing, Norfolk & Southern Ry.

Sir: My attention has been called to an article in your paper of April 21 relative to the Albemarle Sound Bridge of the Norfolk & Southern Ry., and inasmuch as there are some things that are not correct, am writing to call attention thereto.

The first surveys for this crossing were made by the General Engineering & Contracting Co., of New York, Mr. Hockey having charge. Later the writer made surveys and drove test piles across the sound, with the assistance of Mr. F. D. Cosner, who was resident engineer. The data was turned over to Mr. Philip Aylett, then of Portsmouth, Va., who prepared plans and specifications for the bridge, and the contract was then let to the McLean Contracting Co., of Baltimore, for the pile bridge part of the work, and work was begun and quite a lot of this was built before the panic. The contract for the draw spans was let to the Pennsylvania Bridge Co., but this was stopped by the panic after they had done $250 worth of work on the plans. Contract for draw foundations was let to Gwathmey Engineering Co., Norfolk. Mr. Nicholson had absolutely nothing whatever to do with the work in its inception, the work was directly under the supervision of Mr. Chas. O. Haines, Vice-President; Philip Aylett, Consulting Engineer; the writer, Principal Assistant Engineer, and F. D. Cosner, Resident Engineer,

Yours very truly,

T. W. Cothran.

Greenwood, S. C., May 3, 1910.

[Apparently the charge is that statements of proper credit were omitted from our article, and not that we stated "some things that are not correct." Our article was based on a full description prepared by Mr. F. L. Nicholson, Chief Engineer of the Norfolk & Southern Ry. (now the Norfolk & Southern R. R. Co.); but as we omitted some of the names mentioned by him of engineers and contractors connected with the work, the fault if any is partly ours. Mr. Nicholson's share is covered in part by the following remark, in connection with which it is to be said that when work was resumed the surveys and plans were in large part re-made:

> We consider such credit as might be gotten out of it of very little moment, there having been no specially difficult engineering feat accomplished, and while we failed to go into the ancient history in reference to this structure it was not from any desire to discredit any one.

To this we should add that the mention of names of engineers in connection with executed work is often more important as locating responsibility than as giving credit or publicity. And this is more specially true when the work does not depart materially from conventional practice, as in this case. Inasmuch as the existing Albemarle Sound crossing was built under designs worked out by the men named in the article, their responsibility is duly stated.

As the question of the prior history has been raised, the following summary based on statements from the company may be of interest.

Surveys for a crossing of Albemarle Sound at Edenton were made early in the nineties under direction of Mr. M. K. King, General Manager. The route around the shore with a crossing over the Chowan River was surveyed, as an alternative route. The survey records were placed on file and nothing further was done for some 15 years. In 1906, under Mr. M. J. Perry, Chairman of the Board, and Mr. M. K. King, Vice-President, new surveys were made by the General Engineering Co., of New York, including soundings and test-piles. On the basis of these data and some further tests by the railway, the War Department's permit for building the crossing was obtained. Plans for the crossing were then developed, under Vice-President C. O. Haines; as a preliminary new surveys and pile tests were made (showing considerable departures from the preceding survey), and a final location for the crossing fixed upon. Mr. J. W. Stewart was Chief Engineer at first, but he was shortly afterward succeeded by Mr. Gaffney. Mr. Philip Aylett acted as Consulting Engineer. The writer of the above letter was Principal Assistant Engineer. Plans for the trestle, the steel spans

and the piers were developed, the contract for the bascule span was let, and a short length of the trestle, 800 ft. on the north shore and 2,000 ft. on the south, was partially built, of which about 1,000 ft. was completed. This much was accomplished by November, 1907, when work was suspended and all contracts canceled. Receivers for the railway were appointed in July, 1908, and they soon decided to take up the construction again. Mr. F. L. Nicholson was appointed Chief Engineer and Mr. J. E. Greiner was selected as Consulting Engineer. The existing plans were not approved by the new management, and a complete revision was undertaken. The trestle design was changed extensively, the piers for the steel spans were redesigned throughout, and the fender systems were revised to the standard of practice of the Norfolk & Southern. The specifications for the steelwork were modified where not standard. Designs for the steel spans were worked out by the Pennsylvania Steel Co. and approved with some changes by Mr. Nicholson and Mr. Greiner. On this basis the work was carried through, as described in our article of April 21, 1910.—Ed.]

## Records of Deforestation and Gage Heights for the St Croix and Chippewa Rivers.

Sir: It is well known to every student of national law that the restriction of deforestation is not properly a subject of national control unless it can be shown that the conditions materially affect the navigability of streams, which has not as yet been proven, although claimed as an axiom. Attention is also called to the fact that large areas of the original timber consumed by forest fires have been replaced by a second growth of timber, much of it in the form of dense thickets, which shade and protect the ground more effectually even than the original forest. Thus the lumber barons are shown to be public benefactors instead of despoilers of the public weal.

The writer will undertake to show the extent and the effects of deforestation on the two navigable tributaries of the Mississippi, the St. Croix and the Chippewa, which it is believed have been despoiled to a greater extent of their forest growth than any other large streams on this continent or perhaps in the world.

The Chippewa, which has furnished enormous quantities of pine and other timber, has its source near the Michigan boundary of the State of Wisconsin and flowing in a southerly direction joins the Mississippi at Reeds Landing, 77 miles below St. Paul. It is 267 miles in length with a drainage area of 9,530 sq. mi., the greater part of which before deforestation began was covered with forests. Of late years the land from which the timber has been removed has been rapidly taken up by settlers so that there is practically no second growth.

As regards the Chippewa extraordinary overflows or floods occurred in 1838, '47, '55, '58, '66, '80 and '84, but since 1884 there has been no memorable flood. It will be noted that these floods took place before or during the comparative infancy of deforestation. The flood of 1884, the latest of those mentioned (26 ft. at Chippewa Falls, 27 ft. at Eau Claire) was productive of great damage and attributable to an unusually great rainfall over a comparatively small area, in combination with the breaking of two reservoirs containing together 900,000,000 cu. ft. of water, but even this great quantity of water was productive of only an ordinary high-water stage at the mouth of the river.

The St. Croix also rises near the Michigan boundary and flows in a direction parallel to that of the Chippewa. It empties into the Mississippi at Prescott, about 30 miles below St. Paul. It is 168 miles long and its drainage area of 7,146 sq. mi. was once well-nigh covered with forest growth. These lands were formerly thought to be barren and worthless, but since deforestation settlers are rapidly coming in and taking up for cultivation the former sites of pine forests.

The highest floods recorded at Stillwater, 23 miles up the St. Croix, were 19.7 ft. in 1850, 16.9 ft. in 1880 and 17.8 ft. in 1881.

Setting aside for the present the consideration of the precipitation of summer rain and winter snow, which governs in no small degree the extent and duration of floods and low waters, it is found necessary on account of lack of sufficient records of precipitation, except in late years, to use the river-gage records in forming our opinion as to both floods and droughts, and it was further thought best to use the records taken at or near the mouths of the rivers, as being less affected by logging dams and reservoirs than points at a distance up the streams. For this reason gage records for the St. Croix used in the following tables are taken at Prescott, supplemented by those at Hastings, three miles above on the Mississippi, and for the Chippewa at Reeds Landing, and Winona, 38 miles below, which gages in both cases have always been in close accord especially at low stages.

In Table I. deforestation begins with 118 sq. mi. in 1875 and increases to a total of 6,306 sq. mi. at the close of 1900, which is 37.8% of the combined drainage areas (16,676 sq. mi.) of the two streams. While this mileage of deforestation is incomplete, as not including the ravages of former years by lumbermen and the smaller destruction by farmers, it affords a good idea of the enormous extent to which such deforestaion has been carried, and it will be noted that the very highest floods took place before deforestation had made much progress, due attention being given to cases previously cited, especially in regard to the Chippewa.

The quantity of logs cut on the St. Croix and the Chippewa has been ascertained from year to year by the "Northwestern Lumberman." In this article the cut on the drainage areas of the two rivers has also been combined. The cutting and rafting of logs had been going on for many years prior to 1875, the year of our first record, but not on so large a scale as subsequently.

For the past few years the log cut has been chiefly on the upper Mississippi, above the Falls of St. Anthony, as the pineries of the St. Croix, Chippewa, Black and Wisconsin were practically exhausted some years ago. The average cut is estimated at 7,000 ft. to the acre, as ascertained from lumbermen most familiar with log cutting, and with this unit the mileage of deforestation as given in Table I. was calculated.

The low stages at Prescott in 1894 and 1895 were prevalent on the Mississippi River and its tributaries above the mouth of the Missouri and were due to the small precipitation in the summer months.

High water (over 12 ft.) at the mouths of the St. Croix and Chippewa, occurred, as shown in Table I., but none of the high waters, except those of 1880, 1881 and 1897 in the St. Croix, and 1880 in the Chippewa, are to be considered as floods, the remainder being good navigation stages only and not detrimental in any way. It is to be noted, also, that when such good stages occur, the low water periods of the same year are generally higher than mean low water, which may be put at 1.5 ft.

The big floods in the St. Croix and the Chippewa, except that of 1897 in the St. Croix, occurred before deforestation was much advanced, and if we consider the floods of the St. Croix and Chippewa in early years, the influence of deforestation, if any, on floods cannot be considered as detrimental on these streams.

As regards low-water (stages below 1.5 being so considered) the deductions from Table I. are not so obvious, but it is noted that in the 16 years from 1878 to 1893 inclusive, the stage fell below mean low water 12 times, and from 1894 to 1909 inclusive, only 6 times.

The precipitation records for northern Wisconsin, covering the drainage areas of the St. Croix and Chippewa, are available from 1902, only, as observed at 27 stations, and are as given in Table II. The average rainfall at these stations for the last 8 years was 32.95 ins. From this same table (II.) it will be seen that no very high or very low water has occurred from 1902 to 1909 inclusive.

Willis L. Moore, Chief of the U. S. Weather Bureau, says in a recent report, and his deductions harmonize with my own views, that:

On the whole it is probable that forests have little to do with the height of floods in main tributaries and principal streams since they occur as a result of extensive and heavy rains after the ground is everywhere saturated or when heavy warm rains come on the top of deep snows. . . . Rainfall is the result of such fundamental and great causes as not to be appreciably affected by the planting or cutting away of forests. A flood in any kind of a stream is wholly caused by the precipitation from its entire water shed or those of the main tributaries.

My conclusions are that the destruction of the pine forests in Wisconsin has had no effect whatever in creating or increasing floods and droughts in tributary streams or in the upper Mississippi, inasmuch as these features are controlled by precipitation, which has not increased or decreased to any marked extent, at least not during the periods of accurate observations made by the Weather Bureau. The high waters are not higher nor the low waters lower than formerly, nor are they of greater frequency and duration, and the tendency appears to be of late years favorable to navigation in both respects.

Charles W. Durham,
Principal Asst. U. S. Engineer.
Rock Island, Ill., May 16, 1910.

TABLE I.—SHOWING BY YEARS FOR THE ST. CROIX AND CHIPPEWA, THE LOG CUT, THE AREAS OF DEFORESTATION, THE HIGHEST AND LOWEST OPEN RIVER WATERS AND THE PERCENTAGE OF DEFORESTATION.

| Year. | Logs cut, M. ft. B. M. | Area deforested per yr., sq. mi. | Total area deforested sq. mi. | St. Croix at Prescott and Hastings. H. W., ft. | St. Croix at Prescott and Hastings. L. W., ft. | Chippewa at Reeds and Winona. H. W., ft. | Chippewa at Reeds and Winona. L. W., ft. | Percentage of entire drainage area deforested. |
|---|---|---|---|---|---|---|---|---|
| 1875 | 530,032 | 118 | 118 | .... | ... | .... | ... | .007 |
| 1876 | 355,318 | 79 | 197 | .... | ... | .... | ... | .011 |
| 1877 | 204,600 | 45 | 242 | .... | ... | .... | ... | .014 |
| 1878 | 435,238 | 97 | 339 | .... | 0.5 | .... | 0.1 | .020 |
| 1879 | 650,036 | 145 | 484 | 10.7 | 1.1 | 9.0 | 0.7 | .035 |
| 1880 | 919,139 | 205 | 685 | 16.8 | 1.3 | 16.9 | 1.6 | .041 |
| 1881 | 1,000,000 | 223 | 908 | 17.6 | 3.1 | 14.4 | 3.0 | .054 |
| 1882 | 878,284 | 196 | 1,104 | 13.3 | 3.9 | 11.9 | 2.5 | .066 |
| 1883 | 825,640 | 184 | 1,288 | 12.7 | 1.3 | 12.2 | 1.8 | .077 |
| 1884 | 905,148 | 202 | 1,490 | 10.8 | 1.3 | 11.4 | 1.7 | .089 |
| 1885 | 920,249 | 205 | 1,695 | 8.8 | 2.3 | 8.8 | 2.5 | .101 |
| 1886 | 941,676 | 120 | 1,715 | 9.6 | 0.7 | 10.6 | 1.1 | .103 |
| 1887 | 632,550 | 143 | 1,858 | 10.6 | 0.4 | 10.9 | 1.4 | .111 |
| 1888 | 671,328 | 149 | 2,007 | 13.9 | 2.0 | 14.9 | 2.2 | .123 |
| 1889 | 678,495 | 151 | 2,158 | 3.8 | 0.4 | 5.3 | 1.1 | .140 |
| 1890 | 789,427 | 176 | 2,334 | 6.7 | 0.8 | 8.2 | 1.9 | .148 |
| 1891 | 651,372 | 145 | 2,479 | 7.5 | 0.0 | 8.9 | 0.2 | .163 |
| 1892 | 1,125,304 | 251 | 2,730 | 13.2 | 1.1 | 12.1 | 1.5 | .171 |
| 1893 | 1,014,372 | 226 | 2,956 | 14.0 | 0.5 | 12.6 | 1.2 | .189 |
| 1894 | 900,320 | 200 | 3,156 | 13.5 | 0.7 | 13.3 | 0.4 | .202 |
| 1895 | 996,166 | 222 | 3,378 | 6.5 | 0.1 | 5.5 | 0.2 | .212 |
| 1896 | 726,667 | 162 | 3,540 | 12.8 | 0.5 | 9.5 | 0.6 | .230 |
| 1897 | 937,187 | 209 | 3,749 | 16.2 | 3.1 | 12.3 | 2.2 | .236 |
| 1898 | 859,164 | 191 | 3,940 | 14.0 | 1.4 | 9.0 | 0.3 | .247 |
| 1899 | 802,153 | 179 | 4,119 | 11.3 | 2.6 | 8.9 | 1.2 | .258 |
| 1900 | 805,515 | 180 | 4,299 | 8.4 | 0.8 | 8.5 | 0.1 | .272 |
| 1901 | 1,090,651 | 243 | 4,542 | 9.5 | 2.0 | 7.1 | 0.9 | .285 |
| 1902 | 984,577 | 219 | 4,761 | 8.8 | 1.3 | 5.3 | 0.7 | .293 |
| 1903 | 590,424 | 131 | 4,892 | 12.5 | 3.3 | 11.0 | 2.8 | .303 |
| 1904 | 524,513 | 117 | 5,009 | 11.3 | 2.2 | 7.9 | 1.7 | .366 |
| 1905 | 499,082 | 111 | 6,120 | 14.7 | 3.8 | 10.1 | 2.6 | .367 |
| 1906 | 301,564 | 67 | 6,187 | 13.5 | 4.9 | 10.1 | 3.4 | .371 |
| 1907 | 265,748 | 59 | 6,246 | 13.6 | 3.4 | 10.0 | 2.1 | .374 |
| 1908 | 143,839 | 32 | 6,278 | 14.8 | 3.4 | 10.3 | 0.9 | .376 |
| 1900 | 123,283 | 28 | 6,306 | 11.6 | 3.1 | 7.7 | 1.7 | .378 |

TABLE II.—AVERAGE ANNUAL RAINFALL OF NORTHERN SECTION OF WISCONSIN WITH EXTREME HIGH AND LOW WATERS AT THE MOUTHS OF THE ST. CROIX AND CHIPPEWA FOR THE PAST EIGHT YEARS.

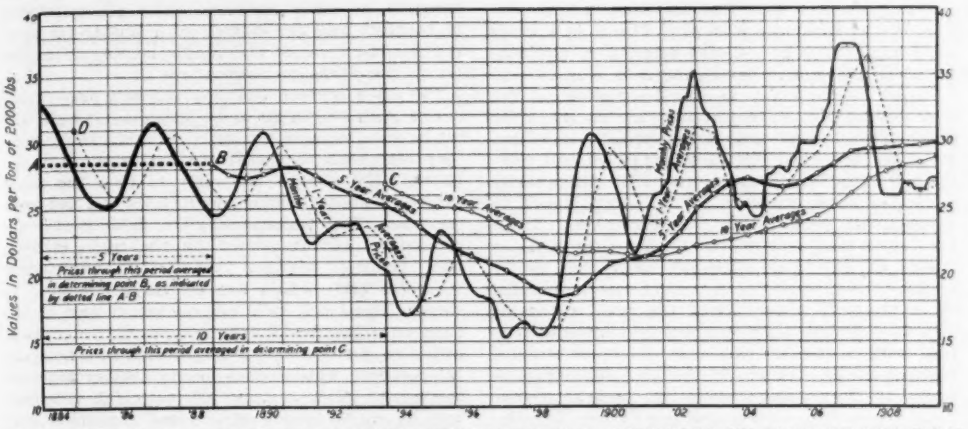
| Year. | Rainfall, ins. | Prescott. H. W., ft. | Prescott. L. W., ft. | Reeds Landing. H. W., ft. | Reeds Landing. L. W., ft. |
|---|---|---|---|---|---|
| 1902 | 30.11 | 8.8 | 1.3 | 5.3 | 0.7 |
| 1903 | 39.60 | 12.5 | 3.3 | 11.0 | 2.8 |
| 1904 | 35.91 | 11.3 | 2.2 | 7.9 | 1.7 |
| 1905 | 35.98 | 14.1 | 3.8 | 10.1 | 2.6 |
| 1906 | 36.11 | 13.5 | 4.9 | 10.1 | 3.4 |
| 1907 | 25.86 | 13.6 | 3.4 | 10.0 | 2.1 |
| 1908 | 29.79 | 14.3 | 2.4 | 10.3 | 0.9 |
| 1909 | 30.26 | 11.6 | 3.1 | 7.7 | 1.7 |

THE EFFECT OF THE PARIS FLOODS on the receipts of the Metropolitan, the local subway, is well shown by figures recently published for the first three months of this year. From Jan. 1 to April 10, 1910, 54,595,145 passengers were carried and the total receipts were 9,159,858 fr., while for the same period in 1909, the corresponding figures were 74,954,829 passengers and 12,697,130 fr. Thus, the floods of January and February of this year, in addition to causing a structural damage of hundreds of thousands of dollars also caused a falling off of receipts amounting to some $600,000 in the three months noted.

TESTS OF PEAT FUEL will be made by the Ontario Department of Mines under the direction of Mr. E. F. Haanel. The government owns a peat bog at Alfred, Ontario, and this will be worked for three months in the coming year to demonstrate processes of air drying. It is expected that several thousand tons of fuel will be manufactured. Part of this supply will be forwarded to Ottawa for use in the government gas-producer plant. The rest of the fuel will be sold for local consumption. The bog can be reached from Caledonia Springs or from Alfred, on the Canadian Pacific Ry., and all interested are invited to inspect the work here as well as at the fuel-testing plant at Ottawa.

## Fluctuations in the Price of Cast-Iron Water Pipe.

The accompanying diagram, showing fluctuations in the price of cast-iron water-pipe, compared on a basis of monthly prices and averages for 15 and 10-year periods, was omitted from the article on the decision of the Wisconsin Railroad Commission in the Appleton Water Works case.




FLUCTUATIONS IN THE PRICE OF CAST-IRON WATER PIPE, COMPARED ON BASIS OF MONTHLY PRICES AND AVERAGES FOR 15 AND 10-YEAR PERIODS.

This diagram illustrates the discussion there given of the basis for unit prices used in physical valuations of the property of public-service corporations.

## The Extension of Telephone Service in the Period From 1902 to 1907.

An advance bulletin on a report of the U. S. Bureau of the Census, covering the equipment, finances and operations of telephone companies in 1907, is at hand. The report itself, about to be issued, has been prepared under the direction of Mr. W. M. Steuart, Chief Statistician, with Mr. T. C. Martin of New York and Mr. Franklin H. Reed of Chicago as consulting experts. The following comparisons are taken from the bulletin and from the 1902 census reports.

The item of most immediate interest is the number of telephone conversations recorded in 1907—approximately eleven billion compared with five billion for 1902, an increase of 124.3%. Concerning this growth the bulletin states:

> The industry is largely concentrated in the populous North Atlantic and North Central states, and the greatest amount of increase between 1902 and 1907 in wire mileage, telephones, and business is shown for them. More rapid rates of increase occurred in other sections, however, and the largest percentages of gain for wire mileage are shown for the Western, South Central and South Atlantic states, where, as a rule, the telephones are farther apart than in the other divisions. The Western States had the largest percentages of increase also in the number of telephones and talks.
>
> The greatest development of the rural telephone service of the country occurred in the North Central states, which by the end of 1907 contained 68.3% of the wire and 72.2% of the telephones in the rural service.

The total number of systems and lines in 1907 was 22,971, as compared with 9,136 in 1902—an increase of 151.4%. The miles of wire increased 165.3% during this period—from 4,900,451 to 12,999,369. The total number of telephones increased from 2,315,297 to 6,118,578, or 163.8%. The average number of employees in 1907 was 144,169, as compared with 78,752 in 1902—an increase of 83%.

The total capitalization (capital stock plus funded debt) in 1907 was reported to be $814,616,004, compared with $348,031,058, in 1902—an increase of 134.1%. The income of 1902, $86,825,536, was increased to $184,461,747, a gain of 112.5%. The total expenses in 1907 were given as $140,802,305, compared with $65,164,771 for 1902—an increase of 116%. The interest on funded debt in 1907 was $12,316,109, compared with $3,511,948 in 1902, an increase of 250.7%. The interest on funded debt appears then to have absorbed 6.7% of the earnings in 1907 and only 4.08% in 1902.

Interest also centers in the figures showing the extent to which the Bell system (The American Telephone & Telegraph Co., with allied operating companies) has obtained a monopoly of the telephone business.

In 1907, the Bell system controlled the use of over half the telephones in the north and south Atlantic, south Central and Western states—in short in 28 states and territories including the District of Columbia. In addition, it is reported that 13.7% of the total number of telephones in service in 1907 were connected to independent exchanges having working agreements with the Bell system for the use of long-distance lines. While there were 22,971 systems, or independent lines, reported in the census of 1907, only 175 belonged to the Bell system—only 0.8%. It is obvious that what is classified as a "system" must therefore include the many exchanges managed by a single operating company.

While the Bell system controlled an insignificant percentage of the actual number of systems and lines, its operations are, of course, far more extensive than that fact would seem to indicate. The Bell lines included 8,947,266 miles of wire or 68.8% of the total and these lines connected 3,132,063 stations or telephones—51.2% of the total reported. In 1902 the Bell lines carried 55.6% of the total number of instruments or stations.

The mutual-association and rural-line systems increased their lines between 1902 and 1907 by 460,447 miles—380.9%. They increased their number of telephones by 546,542 or 376.8%. In 1902 such systems comprised 8.6% of the total reported number of lines and instruments while in 1907 these systems comprised 15.8%. The greatest development of the mutual concerns was found in the North Central states, where was found 78.8% of the number of instruments belonging to such concerns and 79.1% of the wire.

Comparing the growth of the telegraph and telephone services, it is found that in 1907, 14,570,142 miles of telephone and telegraph lines were in use and 89.2% of this, or 12,999,369 miles, was telephone wire. Concerning this comparison the bulletin states:

> In 1880 the telegraph companies reported the operation of 291,213 miles of wire as compared with 34,305 miles reported for the telephone companies. By 1902 the amount of telegraph wire had increased to 1,318,339 miles and the telephone lines to 4,900,451 miles. Thus in 1902 the mileage of wire devoted to the transmission of telephone messages was almost four times as great as that used for telegraph purposes. Both industries developed rapidly between 1902 and 1907, and by the end of that period the mileage of single telephone wire was eight times as great as the telegraph-line mileage.
>
> In the amount of business done in 1907, in the amount paid in salaries and wages during the year and in the capital invested, the telephone business was more than 3½ times as extensive as the telegraph industry, and during the year it furnished employment for more than five times as many persons.

The important percentage changes given above are below tabulated for more convenient comparison:

| | Percentage, increase. |
|---|---|
| Systems or lines | 151.4 |
| Miles of wire | 165.3 |
| Number of telephones | 163.8 |
| Number of conversations | 124.3 |
| Total capitalization | 134.1 |
| Income | 112.5 |
| Total expenses | 116.0 |
| Interest on funded debt | 250.7 |
| Number employes | 83.0 |

| | Percentage of total. |
|---|---|
| Bell telephones, 1907 | 51.2 |
| Bell telephones, 1902 | 55.6 |
| Bell wire, 1907 | 68.8 |
| Bell systems or lines, 1907 | 0.8 |
| Mutual Ass'n, lines and telephones, 1907 | 15.8 |
| Mutual Ass'n, lines and telephones, 1902 | 8.6 |

## The New Bear Valley Dam, California.

The New Bear Valley Dam, San Bernardino County, Cal., which has been under consideration for some time by the Bear Valley Mutual Water Co., of Redlands, Cal., will be of the multiple-arch type, as described further on. It was designed and is being built by Mr. John S. Eastwood, of Fresno, Cal., who in 1908 designed and built the Hume Lake Dam, of the same type, for the Hume-Bennett Lumber Co., of Sanger, Cal.

A year or so ago the Bear Valley Mutual Water Co. and the Southern California Edison Co. engaged Messrs. James D. Schuyler and F. C. Finkle, M.'s Am. Soc. C. E., and Mr. G. O. Newman, each of Los Angeles, Cal., to report on a new dam, to give more storage than is afforded by the famous original Bear Valley Dam. Mr. Schuyler advised a rock-fill dam, with a reinforced-concrete curtain. Mr. Finkle recommended an arched gravity dam, built of concrete. While the company had these plans under consideration Mr. Eastwood proposed a multiple-arch dam, after designs to be made by him. Subsequently the directors of the company accepted Mr. Eastwood's proposition, which involved, Mr. Eastwood informs us, 44% less cost than the plans proposed by either Mr. Schuyler or Mr. Finkle.

In response to a request, Mr. Eastwood has given us the following outline of the dam, which, he states, is the first authentic account of its design to be published:

> The multiple-arch dam now under construction will span the gorge about 150 ft. below the present structure. The new dam will be 327 ft. long on the crest, about 85 ft. high from deepest foundations to the crest (Elev. 6,745, sea-level datum). It will consist of ten spans of 32 ft. each, the arches being supported on eleven buttresses. The height of the vertical head will be 14 ft. at the crown line, and the slope of the water face will be 0.75. The back slope of the buttresses will be 0.5. The buttresses will be stiffened by four lines of strut beams running from solid rock on each end.
>
> The structure is to be heavily reinforced with steel bars, and will be faced with steel ferro-inclave plates to act as forms and for plaster foundation. The factor of safety against crushing will be 12.5 in the weakest point, and the load on the base will be balanced and evenly distributed on the base area.
>
> There will be ten spillway openings, each 4 × 8 ft., the bottom of the spillways being at Elev. 6,732. There are to be four outlet gates set at four different elevations.
>
> When filled to new flow line the storage capacity of the reservoir will be doubled, as compared with the present capacity.

Under date of June 4 Mr. Eastwood stated that ground for the new dam had been broken, roads repaired and camps erected. Cement for the structure was being hauled from Victor by means of 12-horse teams, which require six days to make the round trip between Victorville and the site of the dam. Mr. Eastwood calls attention to the fact that this new dam should not be confused with the Little Bear Valley Dam, now under construction in another part of California.

For the convenience of our readers we append some facts regarding the original Bear Valley Dam, one of the boldest and most adventuresome engineering structures ever built. That dam was erected in 1883-4. Its engineer was Mr. F. E. Brown, of Redlands, Cal., a graduate of the Sheffield Scientific School, Class of 1876, who went to California in 1877. The dam is of the true arched masonry type, with a thickness of about 3 ft. on top, 8⅛ ft., 48 ft. below the crest, and 20 ft. at maximum foundation depth. It has a gross height of 64 ft., a top length of 300 ft., and a radius of 355 ft. The remarkably thin cross-section was due to a combination of circumstances, one of the most important of which was the fact that all tools and cement had to be hauled 70 miles, over two mountain ranges, with the Mojave Desert intervening. Another reason for economy of design and construction was that the dam was built in the very early days of water storage for irrigation in the United States, when data on

the subject were meager. Furthermore, the financial resources of the company, we understand, were limited.

It was originally proposed to carry the first dam to a greater height. Mr. Brown had made plans to this end by or before 1888. He proposed to enlarge the base of the original dam, give it a gravity section and carry it higher. In the following year (1889) Mr. James S. Black, of Redlands, Cal., made plans for a dam 120 ft. high, to be located 150 ft. below the old one. This was to have been an arched masonry dam, but of the gravity type. In 1893 a new project was got under way, in the shape of a rock-fill dam, the foundations for which were laid about 200 ft. down-stream from the old dam. A view of this stonework is shown in Schuyler's "Reservoirs."

The original Bear Valley Dam was described in Engineering News of April 7 and June 23, 1888, the article of the last-named date being a highly interesting personal account of the structure, written by its engineer, Mr. Brown. In Engineering News of Nov. 23 and 30, 1889, Mr. Black's plans for the proposed 120-ft. structure were presented in considerable detail.

## A 120-Ft. Turntable for Handling Mallet Locomotives with Their Tenders; A., T. & S. F. Ry.

The extensive introduction of Mallet duplex locomotives on American railways has developed a number of difficulties in the turning, handling and housing of such immensely long engines at terminal points, and with existing equipment it is often necessary to uncouple the tender when the engine is to be turned. Some of the engines (with their tenders) have an overall length of more than 100 ft. and a total weight of about 350 tons. The Atchison, Topeka & Santa Fe Ry. is using large numbers of engines of this class, and a special type of turntable has been designed and patented by Mr. Frank H. Adams, Engineer of Shop Extensions (at Topeka, Kan.), to meet their special requirements. The following description is condensed slightly from a description prepared by Mr. Adams, and furnished to us by Mr. H. W. Jacobs, Assistant Superintendent of Motive Power. It will be seen that it is of a similar construction to a transfer table, having its main girders supported by wheels at several points; but while a transfer table has a lateral movement on straight tracks, the Adams turntable revolves on a series of concentric circular tracks. The center-pivot serves to hold the table in position and does not carry any load.

Fig. 1 shows a half plan and longitudinal section of the turntable and pit. Fig. 2 is a cross section. Figs. 3 and 4 give sections of the center guide plates and bevel-gear rack respectively.

In his introduction to the description of the new design, Mr. Adams states that railways for years have turned their locomotives and rolling stock on turntables centrally supported and having end supports to take the load temporarily while the locomotive or car is being moved to a balanced position on the turntable. These turntables may be revolved by hand through the means of extended levers at each end, or by means of a pneumatic or electric motor mounted on a platform hinged from the main turntable structure and driving a wheel in frictional contact with a circular rail near the outer circumference on the bottom of the pit. The tractive force of this wheel due to the weight of the hinged platform, motor and mechanism is sufficient to revolve the turntable when the load is balanced and the table is in good working order.

The size and weight of locomotives and rolling stock has been increasing rapidly during the past few years until some locomotives represent (with the tender) a combined weight in working order of about 350 tons and an extreme length over all of about 110 ft., while the largest types of locomotives of only a few years ago did not exceed 175 tons in weight or 75 ft. in length over all. It is desirable to turn these larger and longer locomotives without disconnecting the tender, but 85 to 90 ft. seems about the limit of length for a centrally-supported turntable that will be practical and economical, and which can be built within a reasonable expenditure. It is therefore important that suitable means be provided for turning these new engines by providing a turntable longer and of proportionately less cost than tables of the ordinary type, and by providing simple and positive mechanism for revolving the table.

In Mr. Adams' design (Fig. 1) there is a pit of sufficient diameter and depth to contain the table, and having suitable foundations (A) (B) and (C) for circular tracks which are secured to the foundations by means of anchor bolts. These are laid in circles and so spaced as to result in a uniform span between the supported points of the main girders (D) and (E) at (F), (G) and (H). A foundation is also provided at the center of the pit to which is bolted the bottom center guide casting (J). The pit may be paved with concrete or other material. The pit walls are of concrete and are capped with timber for supporting the rails of the tracks leading from the pit to the yards or roundhouse.

The main girders (D) and (E) are plate girders of such length as to be contained within the pit and of suitable strength to carry the necessary load with the predetermined uniform spans (F) to (G), (G) to (H), (H) to (K), the table structure and pit being symmetrical on the center line. The transverse plate girders (L) are riveted to and supported by the main girders, and support between them the longitudinal stringers (M), which are of varying depth, as shown. The track rails are on top of two of the lines of stringers. To the bottom of two of these stringers is riveted plate-girder (N), in a horizontal position. This carries on its bottom face the top center guide casting (O), to which reference will be made later. Struts and diagonals give rigidity in a horizontal plane to the whole structure.

Rigidly secured to the bottom of the main girders at each point (F), (G) and (H), in a fixed position parallel to a tangent to the circular tracks, is a pair of I-beams (P). These are parallel and continuous transversely under the whole structure, being rigidly secured to the girders and the longitudinal stringers (M), and bent so as to be parallel with the tangent of circular track at the longitudinal center line of the table. To the tops of these I-beams are bolted journal bearing boxes (Q), each pair being so located as to have the common center line of the bore intersect the center of the pit and table, or (in other words) in a radial line of the pit and table. In each pair of journal bearing boxes, there is an axle having keyed to it a wheel (R) in such a manner that the extended center line of the axle intersects the center of pit and table and the plane in which the wheel and axle revolves is parallel at the point of contact to the tangent of the circular track.

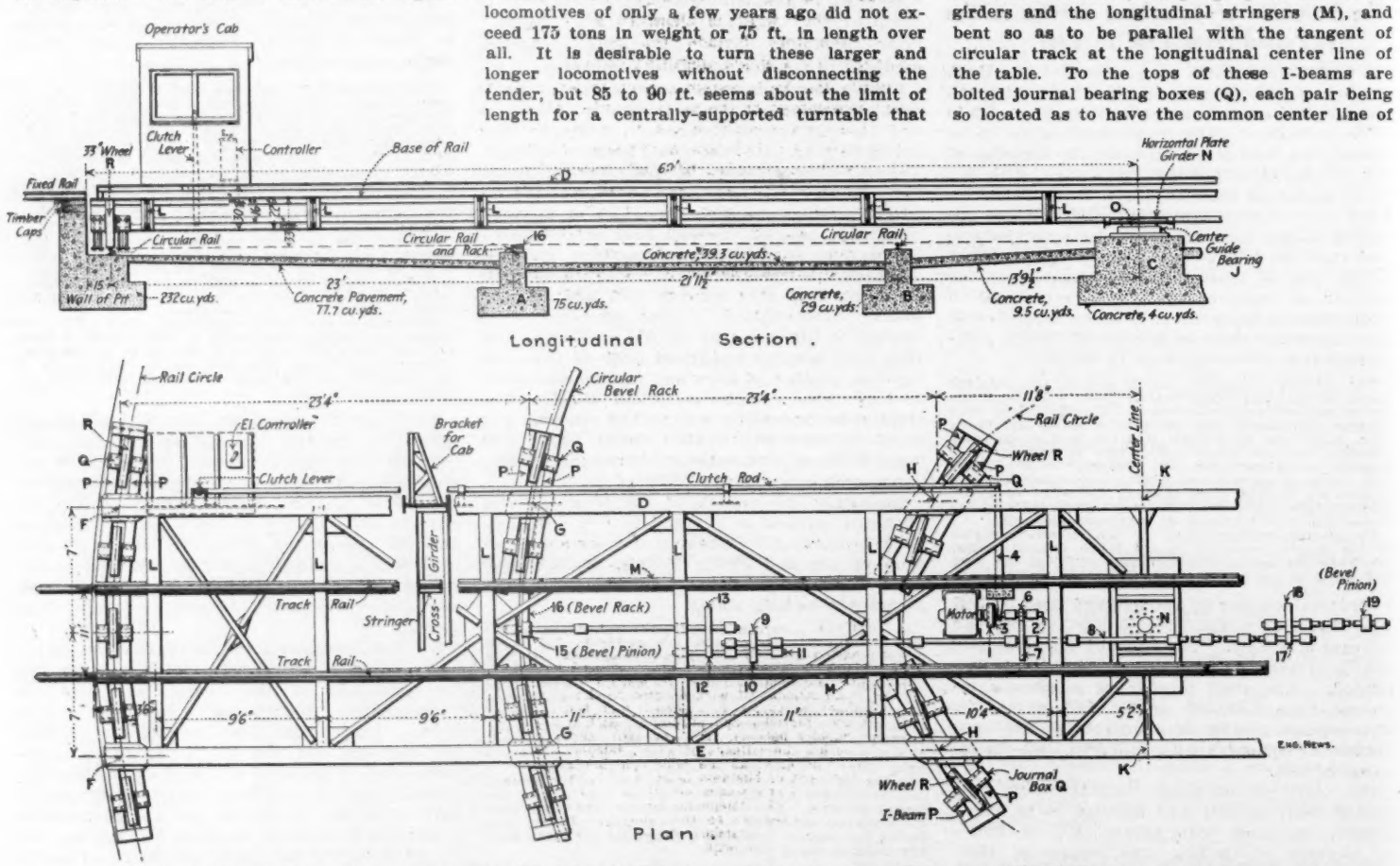



FIG. 1. A 120-FT. TURNTABLE FOR MALLET LOCOMOTIVES, WITH THEIR TENDERS; ATCHISON, TOPEKA & SANTA FE RY.
(Frank H. Adams, Engineer of Shop Extensions, Inventor and Designer.)

The wheels may be with or without flanged treads as other means are provided for keeping the table central in the pit, as explained later.

As stated above, to the bottom of the plate-girder (N) is bolted the top center-guide casting (O) which has a finished surface revolving within the lower cup-shaped bottom center-guide casting (S), secured to the central foundation of the pit. This detail is shown in Fig. 3. Through the bottom of the bottom casting is provided a

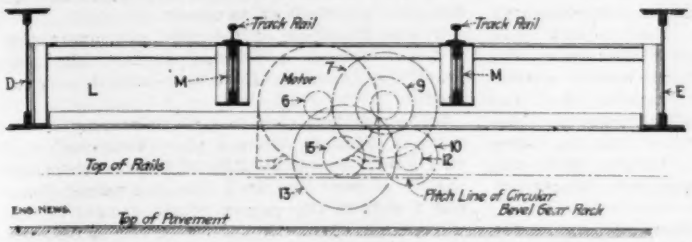



FIG. 2. CROSS SECTION OF TURNTABLE, SHOWING ALSO THE ARRANGEMENT OF GEARING.

1½-in. pipe for convenience in bringing electric wiring to the table. The bottom casting is designed with a view of filling with oil to the level shown, to insure perfect lubrication at all times. It should be understood that this center arrangement, shown in cross section in Fig. 3, sustains no part of the weight of the table or load. Its function is to maintain the table central with reference to the pit and the circular rails.

In Fig. 1, an electric motor (although any other convenient power may be used) is shown located between the girders and supported in any convenient manner. The extended shaft of the motor carries one-half of the friction coupling (1). The short shaft (2) is mounted in bearings supported from the table structure; it is in line with the motor shaft, and to its end toward the motor is connected the sliding half of friction coupling (3). By means of the forked lever (4), the extended hub of this part of the coupling may be shifted on shaft (2) and brought into frictional tapered contact and rotative connection with the fixed half (1) on the motor shaft. The gearing is shown in Figs. 1 and 2.

To shaft (2) is keyed a pinion (6) which engages the gear wheel (7) keyed to shaft (8). Holes are provided in the girders through which this shaft passes, and occasional couplings in the latter facilitate its installation and removal. Gear wheel (9) is keyed to shaft (8), and engages gear wheel (10) keyed to jack shaft (11) which carries pinion (12), engaging gear wheel (13) on shaft (14). To this shaft is keyed bevel pinion (15) which engages the circular bevel-gear rack (16) secured to the circular rail and extending round the full circle. The pinion is 11 ins. pitch diameter, and runs at 45 r. p. m., or 130 ft. per minute. Shaft (14) being on the center line of the table is on the radial line of the pit and circular bevel gear rack. At the opposite end of the table is a train of gearing (17) (18) from shaft (8) to bevel pinion (19), running in the opposite direction to pinion (15).

It has been found convenient in practice to operate a turntable from a position near one end of the table, therefore an operator's cab is provided at one end, supported from the main girder by brackets. In this cab are located the operator's clutch lever and the motor controller.

To revolve the table, the motor is started and allowed to attain full speed under no load. Then by means of the lever in the cab, with its connections, the sliding half of the friction coupling is shifted into connection with the half keyed to the motor shaft. The power of the motor is then transmitted through the gearing and shafting to the two bevel pinions which respectively engage the circular bevel-gear rack in opposite directions imparting a revolving motion to the whole table and its supported mechanism.

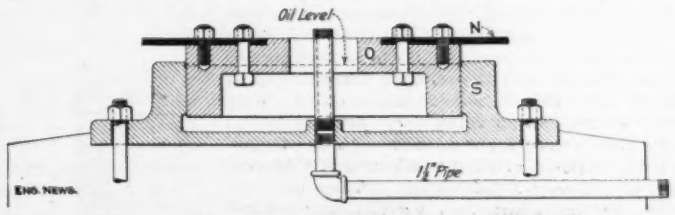



FIG. 3. CENTER PIVOT FOR 120-FT. TURNTABLE.

## Street Railway Development in the United States from 1902 to 1907.

The statistics of the industrial activities of street and electric railways were collected in 1907 by the Bureau of the Census, Department of Commerce and Labor, and the report on the compilation was prepared under the supervision of Mr. Wm. M. Steuart, Chief Statistician of the Bureau, and of Mr. T. C. Martin, consulting special expert. An advance bulletin has been issued presenting a general summary of the figures found. This bulletin states that

the universal adoption of electricity as a motive power for street railways and the extension of these railways into rural districts made it impracticable to separate the statistics of street railways from those for the interurban railways. The present figures therefore, like those from the census of 1902, cover all railways using electrical energy as motive power, and also the street railways operated by animal power, cable, gasoline motors and steam.

In 1902 there were 21,907.59 miles of track operated for electric traction and in 1907, 34,059.69—an increase of 55.5%. The trackage under animal power in 1902 was 259.10 miles and in 1907 136.1—a decrease of 47.5%. In 1902 there were 240.69 miles of cable road, and in 1907 only 61.71 miles—a decrease of 74.4%. In 1902, 169.61 miles of such light railways were run by steam, and in 1907, 146.05—a decrease of 13.9%. The total length of all such tracks in 1902 was 22,576.99, while in 1907 it had risen to 34,403.56—an increase of 52.4%. Considering only main tracks, the figure of 16,645.34 for 1902 had been increased to 25,547.19 miles—a rise of 53.5%.

The report continues:

The comparative summary for 1907 and 1902 shows that the total number of operating and lessor companies in the United States in 1902 was 987 and in 1907, 1,236—an increase of 25.2%. The operating companies in 1902 numbered 817 and in 1907, 945—an increase of 15.7%. The lessor companies in 1907 numbered 291 and in 1902, 170, the per cent. of increase being 71.2. Measured by trackage, the average operating company reported in 1907 was about 3½ times as large as the average company in 1890, but only ½ larger than in 1902.

The greatest actual increase in the net trackage in any state was reported for Ohio, the increase amounting to 1,337.36 miles. The next largest increases were in Indiana, with 1,272.15 miles; Pennsylvania, with 1,257.49 miles; California, with 1,184.39 miles; Illinois, with 1,096.15 miles, and New York, with 1,011.29 miles. The largest relative gain occurred in Idaho, when the track increased from 3.50 miles in 1902 to 73.09 miles in 1907, or 1,988.3%. The smallest actual increase, three miles, was reported by South Dakota, while the lowest rate of increase, 9.5%, is shown for the District of Columbia and Montana. The large gains in the mileage of track in Ohio, Indiana, California, and Illinois are credited mainly to development of interurban lines, while the increases in Pennsylvania and New York are due to the growth of both urban and interurban lines.

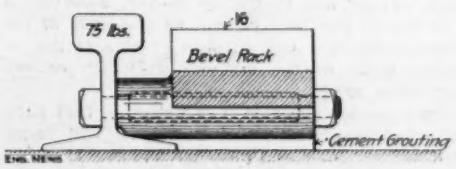



Fig. 4. Circular Bevel Rack for Operating 120-Ft. Turntable.

There were 101 companies reported at the census of 1907 as having properties under construction, but not in operation during any portion of the census year. This indicates, approximately, the amount of new development work in progress in 1907. These companies reported 675.85 miles of track as completed by Dec. 31, 1907, and an estimated total of 3,101.30 miles of track for the roads when completed. Their total outstanding capitalization had a par value of $232,298,844.

The cost of construction and equipment had risen from $2,167,634,077, in 1902, to $3,637,668,708 in 1907—an increase of 67.8%. The total capitalization (capital stock plus funded debt) of operating and lessor companies in 1902, was $2,308,282,099, and in 1907 it had risen to $3,774,772,096—63.5% more.

The gross income of the operating companies in 1902 was $250,504,627, and in 1907 it was $429,749,254—an increase of 71.6%. These figures have been split into "operating and other income"; the operating income in 1902 was $247,553,999, and $418,187,858 in 1907 (68.9% greater), while income from other sources in 1902 was $2,950,628, and $11,556,396, in 1907 (an increase of 291.7%). Concerning this, the bulletin states:

the item of income from other sources than earnings from operation comprises interest and dividend on securities of other electric railways, income from other permanent investments, and income from miscellaneous sources, such as interest on deposits and rentals from real estate. The high percentage of increase in income from such sources reflects the extent to which electric railways have become connected with these miscellaneous interests.

The operating expenses in 1902 were 57.5% of operating revenue and in 1907 they were 60.1%.

In 1902, there were, in all, 66,784 cars in use, while in 1907 this number was increased 25.2% to 83,641. Out of these numbers, in 1902, there were 60,290 passenger cars in use and 70,016 in 1907—16.1 increase here. Cars not for passengers increased from 6,494 in 1902 to 13,625 in 1907—109.8%. This unusual increase is accounted for by the development of freight business on interurban lines. Another factor entered, as shown in this statement.

It is noted that the average number of passenger cars per operating company (74) was the same at the census of 1907 as that of 1902, this being a result of the general use of larger cars at the latter census.

This is also reflected in the number of passengers per car per year given below.

The car mileage, including passenger, express, freight, mail, etc., in 1907 was 1,617,731,300, as compared with 1,144,430,466 in 1902, an increase of 41.4%.

The total number of passengers in 1907 was 9,533,080,766, as against 5,836,615,296 in 1902, an increase of 63.3%. The number of fare passengers in 1907 was 7,441,114,508, as compared with 4,774,211,904 in 1902, an increase of 55.9%. The number of transfer passengers in 1907 was 1,995,658,101, and in 1902 it was 1,062,403,392, an increase of 87.8%. The number of "free" passengers in 1907 was 96,308,157.

The number of fare passengers per mile of track in 1907 was 216,522, and in 1902 it was 212,217, the increase being only 2%. The average number of "fare" passengers per car per year was 106,277 at the census of 1907 as compared with 79,187 for 1902 and 62,337 for 1890.

In 1902 these companies operated 805 power stations and in 1907 this number was 829—an increase of only 3%. Steam and gas engines and water wheels used in generating plants for these roads were reported as having 1,349,211 HP. capacity in 1902, and 2,476,479 HP. in 1907. This is an increase of 83.6%. The capacity of electric generators in these stations increased from 898,362 KW. to 1,723,416 KW. in this period—an increase of 91.8%. The bulletin comments on this growth.

A number of companies operating electric railways engaged also in other business, such as generation and sale of electric current and the manufacturing and sale of gas, ice, etc. The generation and sale of electricity by electric-railway companies for general commercial use, it is stated, are frequently so closely allied to electric-railway operations that it was found impracticable in the report to separate the two branches of the industry. In such cases the data for both branches are included. It is stated that bridge properties, canals, amusement parks and resorts, and turnpikes, which have been constructed or acquired by electric-railway companies, are, as a rule, covered by the capitalization of the railways, and statistics for them are included with those for the railways.

The several percentage increases showing the growth of the street and electric railways of the

country along the many lines discussed have been tabulated below for easier comparison:

| | Per cent. Increase. |
|---|---|
| Total trackage | 52.4 |
| Main trackage | 53.5 |
| Operating companies | 15.7 |
| Lessor companies | 71.2 |
| Total companies | 25.2 |
| Cost construction and equipment | 67.8 |
| Total capitalization | 63.5 |
| Operating income | 68.9 |
| Non-operating income | 291.7 |
| Gross income | 71.6 |
| Operating expenses | 76.4 |
| Total cars in use | 25.2 |
| Passenger cars in use | 16.1 |
| Non-passenger cars in use | 109.8 |
| Car mileage | 41.4 |
| Total passengers | 63.3 |
| "Fare" passengers | 55.9 |
| Transfer passengers | 87.8 |
| Fare passengers per track-mile | 2.0 |
| Fare passengers per car-year | 34.3 |
| Power stations | 3.0 |
| HP. capacity (prime movers) | 83.6 |
| KW. capacity (generators) | 91.8 |

## A Novel Welded Frame System of Reinforcement for Concrete.

A thoroughgoing attempt to deal with the problem of producing integral reinforcing frames is represented by a new style of concrete reinforcement just introduced by the Pittsburg Steel Products Co., of Pittsburg, Pa. The fundamental idea of the new system is joining the bars of the frame by electric welding, and in order to make this a simple and reliable operation the bars are formed with beads or ribs adapted to give spot welding contacts where two bars cross. This conception is due to Mr. J. O. Ellinger, long engaged in concrete work in this country.

To work out a system of standardized reinforcement frames on the basis of this type of weld connection the company engaged as consulting engineer Mr. Wm. Barclay Parsons, 60 Wall St., New York City. Guided by tests made in the laboratory of the Bureau of Standards, the weld connection details were developed to a point where the joint formed between main bar and shear strap is stronger than the shear strap. Mr. Parsons then selected the necessary range of sizes of main bars and shear straps, designed the various possible groupings to produce all required sizes of beams, and fixed the essential elements of all such beams. In the course of this work a series of full-size beam tests was conducted, to fix the best arrangement of bars, and it was determined from the results of these tests to use shear straps inclined at 45° to the main bars. This arrangement gave stronger beams than the arrangement with vertical shear straps, apparently because with the latter there was excessive crushing stress on the concrete in the corner between shear bar and main bar.

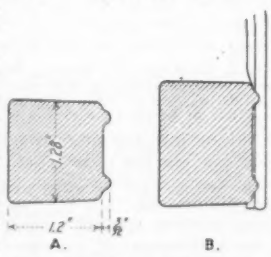



Fig. 1. Type of Main Bar and Welded Connection Between Main and Shear Bar; Pittsburgh Steel Products Co. Reinforcement System.

The type of main bar is shown at A in Fig. 1 herewith. The two longitudinal ribs along one face furnish the weld contacts. The shear straps are thin bars with either one central rib or two ribs like the main bars. The joint between the two bars is made by simply placing the ribbed faces together in proper position and passing a heavy electrical current through the junction under pressure, giving a result as sketched at B, Fig. 1.

The main bars are rolled in 17 sizes, equivalent in area to square bars from ½ × ½-in. to 1½ × 1½ ins. They form four groups, the width of bar (from bottom of ribbed face to back) being constant in each group (0.4, 0.7, 1.0 and 1.2 in. respectively). The bars of a reinforcing frame must be of one group. The smallest bar is 0.4-in. wide by 0.56-in. deep, while the largest is 1.2 × 1.85 ins. The bead section is the same in all cases, $^3/_{16}$-in. wide at bottom by $^8/_{32}$-in. high, with $^1/_{16}$-in. radius of edge.

The shear straps vary in width from ½-in. to 1½-ins., and in thickness from ⅛ to $^9/_{16}$-in. They as well as the main bars are hot-rolled of open-hearth structural (medium) steel, of strength 60,000 to 70,000 lbs. per sq. in.

The adopted standard reinforcing frame is represented by Fig. 2. Top reinforcement at the ends is an essential element of the system, and the amount of this is recommended to be one-fourth of the bottom reinforcement; two bars are used at the bottom and one at the top (over the outer quarters of the span only). One of the bottom bars is continuous, the other is cut off at a point where the decreasing moment makes it unnecessary. The top bar is intended to run over into the adjacent beam in the case of an interior span, and at least to the middle of column in the case of an end span.

An elaborate set of size and strength tables for beams using this system of reinforcement has also been compiled by Mr. Parsons. It has separate tables for "beams" and "girders" for building

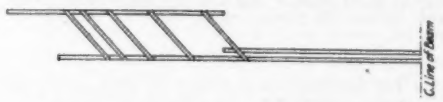



Fig. 2. Typical Beam Reinforcement Frame.

use. The tables are based on the Joint Committee's formulas and specifications, using as working stresses 16,000 lbs. per sq. in. for the steel and 650 lbs. per sq. in. for the concrete. Both beams and girders are designed to use a slab width not exceeding (12 × thickness of slab) as compression area; this selection was confirmed as permissible by the beam tests above referred to.

A new style of slab reinforcement has been designed to go with the above-described beam reinforcement. It consists of a meshwork welded at the intersections by electric current. The tension bars run in one direction only. They are V-shaped strips formed by bending a flat strap at 90° along its middle line. The bars are of ½-in. to 1½-in. original width, and of thickness from No. 11 to No. 20 gage. They are laid trough up, 4 ins. apart, on a set of spacer wires set 6 to 12 ins apart. This meshwork is welded at the joints to form sheets of any width from 4 to 6 ft. wide, and of maximum length 20 ft.

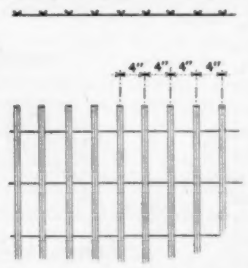



Fig. 3. Welded-Mesh Slab Reinforcement.

## Cement Stucco Finishes for Walls.

By ALBERT MOYER,* Assoc. Am. Soc. C. E.

According to the dictionary definition stucco is "plaster or cement, of varying degrees of fineness, used as a coating for walls, either internally or externally, and for the production of ornamental effects and figures." In the remote past this finish was very popular as a covering for the inferior and less pleasing building materials such as poor stone and brick, and for that purpose it is probable that lime was mostly used. There has grown up to-day, however, a wide use of Portland cement as the basis of the stucco, and it is the purpose of this article to outline some of the methods in which cement may be so used.

From the artistic side it is desirable that such surface finish be given to stucco as will cause both natural color and pleasing texture. It would be well, therefore, to expose to view the aggregates used and avoid as far as possible exposing the bonding material, Portland cement. There is no artistic reason for allowing only the bonding material to be displayed to the eye. On very large jobs the surface can be cleaned off by means of a sand blast, and on smaller jobs the surface may be cleaned exposing each grain of sand by means of muriatic acid in dilute solution, 1 part commercial muriatic acid, 4 to 5 parts clear water. Where white aggregates are used the surface may be cleaned off with a solution of sulphuric acid, 1 part acid, 4 to 5 parts clear water. The sulphuric acid leaves a white deposit and therefore should not be used excepting where the aggregates are white.

Another method is to scrub the surface while yet green, say within 24 hours, with a house scrubbing brush and clear water. This is more difficult than the others for the reason that if the stucco is allowed to remain too long before scrubbing, it will be too hard to remove the coat of neat cement from the outside of each particle of sand or other aggregates; and if scrubbed when it is too soft the surface may be damaged and difficult to repair.

If the character of the available aggregates will not present a pleasing surface when exposed the following surface treatment may be used:

While the last coat is still thoroughly damp, apply a Portland cement paint composed of 1 part Portland cement, 12% of the volume of the cement of well hydrated lime, pulverized form, and 1 part of the volume of the cement of fine white sand. Mix with water to the consistency of cream or the ordinary cold water paint. Stir constantly and apply by using a whisk broom throwing the paint on with some force. Keep this finish surface damp for at least six days, or longer if economy will permit. Do not allow it to dry out in any one place during the week. If necessary protect by hanging tarpaulins and using a fine spray of water playing on several times during the day by means of a hose. This will give a pleasing light gray color of excellent texture.

Stucco may be applied to various building materials. There is hardly any reason at the present time for stuccoing stone buildings, the procedure at best is difficult and hardly to be recommended. Our building stone is usually an excellent material and, therefore, does not require either protection or covering to produce pleasant effects.

New brick may be covered with stucco very successfully. The joints should be first raked out, about ½-in. The brick must be saturated with water. It is always best to start stuccoing at the top of the wall and work down between the pilasters or corner; finishing a whole strip or whole side wall from top to bottom in one day. Thus, no streaks or cracks are formed where one day's work ends and another begins. By this method the wall can be kept wet ahead of the work by means of a hose.

The second coat should be put on as soon as the first coat has stiffened sufficiently to hold in place and stand the pressure of the trowel. This second coat should be well scratched and the finished coat applied while the second coat is damp. The finish coat should then be kept wet, protected from the rays of the sun and as far as possible from drying out. This can be done by hanging wet cloths over same. This rule of keeping each coat moist until the other coat is applied and protecting after applying the finish coat, must be observed in all forms of Portland cement stucco.

If the stucco is to be applied to metal lath or wire cloth the metal should be plastered on two sides so that it is entirely encased in mortar in order to avoid rusting. If this is impracticable then the metal lath or wire cloth should be dipped in a paint made of equal parts of neat Portland cement and water. Immediately after dipping, the metal lath or wire cloth should be tacked onto a frame in the position it is intended to occupy. As soon as the neat Portland cement has hardened on the metal apply the first coat of stucco. Hair should be added to the mortar to be applied on wire mesh or expanded metal, in the proportion of one bag of cement to one pound of hair.

If plaster boards are used they should be nailed on the framework of the building, leaving

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at least ¼-in. joint between each plaster board. This joint should be filled in with lime putty, otherwise each plaster board will cause square cracks on the outside of the stucco the size of each board.

A convenient method of waterproofing plaster boards is easily available. The boards may be painted with two coats of any of the reputable bitumen waterproof paints to which plaster adheres. Then about 24 hours after the bitumen paint has been applied, and within six days as a limit, apply the first coat of stucco.

For stucco on terra cotta blocks great care should be exercised in keeping the blocks thoroughly saturated with water, for if the blocks are not saturated they will pull the water out of the mortar and it will crack and disintegrate. Portland cement requires water until it has thoroughly hardened, which ultimate hardening usually takes from 14 days to a month. It is not always necessary to play the hose on the wall for a month, although it would be advisable. The dews at night, the dampness in the atmosphere and the rain will furnish the necessary moisture provided the material on which the mortar has been plastered has not too great an affinity for water.

In order to prevent the porous hollow terra-cotta tile from sucking the moisture from the stucco and also to furnish waterproofing and an additional bond other than that which would be given by the key, it is good practice to paint the surface of the dry terra-cotta blocks after having been erected in the wall with two coats of bituminous paint. It is important that the first coat of stucco is placed over this paint after 24 hours and within six days.

Proportions for a good stucco should be 1 part Portland cement, 2½ parts coarse clean sand. (If coarse clean sand is not available use only 2 parts of sand.) Add 10 to 15% of well hydrated lime, dry pulverized, of the volume of the cement.

If it is the desire of the owner or architect to use the exposed aggregate method, interesting natural colors can be obtained by using, in the same proportions as noted above, the following materials instead of sand: green, red, buff, black or white marble screenings all passing a No. 8 screen and all collected on a No. 40 screen. These different colored marbles and different colored sand where obtainable, can be used singly or in a combination. When exposed by scrubbing or the acid treatment very artistic results are obtained.

In mixing stucco great care should be exercised to obtain the thorough incorporation of cement, sand and other aggregates. The sand and cement should be mixed together dry until an even color results. This can be done by shoveling and raking while shoveling. Water should then be added, being careful not to add too much water at a time and not to get the resulting mortar too wet so that more sand or cement has to be added. Be very careful to bring the resulting mortar up to the proper consistency for plastering.

It is advisable to add to the mortar from 10 to 15% of the volume of the cement of well hydrated lime. This should be mixed dry with the cement and sand before the water is added. The addition of hydrated lime tends to fatten the mortar, making it more adhesive and impervious.

The color obtained by the scrubbing or acid method is limited only to the available sands or marble screenings; the color will be the color of the aggregates. An excellent green can be obtained by adding 8% of the weight of the cement of chromium oxide. This should be mixed dry with the sand, cement and hydrated lime.

Always keep in mind that the surface to which the mortar is to be applied must be thoroughly saturated with water, each coat of stucco must be kept moist and the final coat must remain moist for at least one week and longer if economy will permit.

Stucco should not be troweled to a smooth surface. The artist painter would never think of smoothing the paint on his canvas by means of a straight edge. Texture and color are necessary if artistic results are to follow. By using the suggestions above outlined, the architect is privileged to select the aggregates from which the stucco is made and has, in fact, as great play in the planning of the color, tone and texture as has the artist in mixing the paints on his palette.

## Annual Convention of the Master Car Builders' Association.

The 44th annual convention of the Master Car Builders' Association was held at Atlantic City, N. J., June 15 to 17, in connection with the annual convention of the American Railway Master Mechanics' Association on June 20-22, and the usual immense exhibition of railway appliances and machinery on Young's Million Dollar Pier.

Of late the Master Car Builders' annual meetings have covered three days, from 9.30 a. m. to 1.30 p. m. of each day, and it has been generally found that the time was hardly sufficient to take care of the desired business. This year the meetings were arranged to be from 10 a. m. to 12.30 p. m. and from 2 to 4 p. m. on each day of the three days, but it happened that the afternoon sessions were not necessary on the last two days, the whole day's program being cleaned up in the morning. This was due to two things: the more extensive papers and reports were read only in abstract and there was an absence of much of that perfunctory, fruitless discussion on the floor that characterizes so many conventions.

By far the most important function of the association is the promulgation of the rules of car interchange and repairs that are observed by the railways of the country and the arbitration of the disputed cases of such interchange. This year, more than ever before, all of this matter was threshed out in committee and in public hearings before committee so that when the subject of interchange and arbitration was brought before the association in convention, there were no objections to the committee's rulings and its report was accepted in short order. Another important duty of the association is the establishment of the standards of car construction, which standards are observed by the subscribing roads. This year minor changes were recommended by the committee and, for the most part, adopted.

Owing to the new constitution, adopted last year, the requirements for membership in the association were made somewhat more rigid and this removed some of the deadwood from the membership list and reduced it slightly. There are now 377 active members, 332 representative members, 14 associate members and 19 life members, a total of 742. The cars represented in the membership aggregate 2,298,633. The finances are in their usual flourishing state, although the President reported, with regret, that the $5,000 Tillotson legacy, mentioned in our issue of July 1, 1909, page 12, probably could not be accepted on account of certain legal restrictions that have since been discovered.

### Consolidation with Master Mechanics' Association.

For some years the question of the consolidation of the Master Car Builders' Association and the American Railway Master Mechanics' Association into one general railway mechanical association has been a leading point of discussion, both in and out of the conventions of the two societies. To understand the underlying reasons for the desirability of such a consolidation the nature of the two associations, their history and their methods of work should be explained. Started over forty years ago as entirely separate organizations, for many years each society held its own meeting apart from the other. In those early days the car department and the locomotive department of the railways were not particularly close in their relations and the heads of each were supreme in their own field, each reporting to some superior officer. Gradually, however, in nearly every railway company the car department has been put under the supervision of the mechanical department, the head of which almost invariably has come up through the locomotive branch. It has thus come about that the members of the Master Mechanics' Association, as they increase in age and official responsibility, have had supervision, each in his respective railway, of the work covered by the deliberations of the Master Car Builders' Association, and on account of this power have joined the latter association. A perusal of the membership list of that society will show that many of its members are Master Mechanics, Superintendents of Motive Power, Mechanical Engineers, etc., and the number of Master Car Builders, Car Inspectors, etc., if not in the minority, is at least not in any overwhelming majority. About two years ago the practice was started in the Master Car Builders' Association of electing as executive officers only the mechanical officials of railways.

This, then, is probably the main reason why it has been thought best to incorporate the two societies into one. The next reason is that the present scheme of having two conventions covering eight days, with two intervening blank days, takes up too much time of the railway officials who, by virtue of their interest in both meetings, must be away from their offices for from ten days to two weeks or more, depending upon the distance of their homes from the convention place. Finally, the deliberations of the two associations quite often include the same topics, an obvious waste of time and labor.

At the same time, as we have noted above, the Master Car Builders' Association is a legislative body, formulating rules of car interchange observed faithfully by all railways, and with this function the other society has nothing whatever to do. To rearrange the organization which in over forty years has built up an easy-working, respected court of last resort, would perhaps tend to disturb a system upon which the successful operation of cars depends.

With all this in mind the Master Car Builders' Association last year appointed a committee which, acting jointly with a similar committee from the sister association, reported this year upon the advisability of such a consolidation. This report states impartially the advantages and disadvantages of the proposed union, mainly as outlined above, and without committing itself upon the question, submitted, as directed, a proposed constitution for "The American Railway Mechanical Association." This report was discussed freely on the floor and was then laid upon the table, to be referred to the members and to the executive committee for consideration during the year to come. The matter is of such concern to the Association that it was thought best that due deliberation should be observed.

The discussion on the floor showed quite clearly, we think, that there is a decided sentimental objection on the part of the Master Car Builders' Association to any consolidation, because the members fear that the ultimate result will be absorption rather than a coordinate union. In fairness to the speakers, it should be said that there were other arguments put forth, but back of the arguments the sentiment of the members, quite clearly expressed in applause, was that the Master Car Builders' Association, an old, honorable and respected society, would become only a working part of the other society. The arguments presented, briefly stated, were (1) the new society's meetings would be too concentrated and long to allow of the proper attention; (2) there would be no chance to study the admirable exhibit on account of the meetings; (3) the absorption of the Master Car Builders' Association would still further reduce the importance of that branch of railway work so that it would be next to impossible to interest the young man in the car department, where young men are certainly needed, and (4) the subject of car design and construction would be largely taken from the hands of the practical car man and put in the hands of the mechanical engineer, who is not as capable of handling it. It will be seen that the first two of these arguments involve the matter of convention arrangement which, it can be assumed, may be arranged

more satisfactorily than at present proposed. The third argument is somewhat intangible and certainly indirect, for the consolidation would only be an expression of underlying conditions in railway operation. The last argument may be basically correct but, as a matter of fact, the work of the Master Car Builders' Association, through its committee, is carried on by the mechanical railway men and not by the practical car men. Only 25% of the representation on those committees is made up of practical car men; the remaining 75% are from the higher mechanical officers.

The matter is now at a standstill, but observation of the past few years leads us to believe that the Master Car Builders' Association will be forced reluctantly to the union. It will be a slow process, but it seems inevitable.

### Safety Appliances.

During the present session of Congress a bill was passed and signed by the President, giving the Interstate Commerce Commission enlarged power to regulate and prescribe the safety appliances on railway rolling stock. On account of the uncertainty as to the procedure of the Commission in this matter the Committee on Safety Appliances did not make any specific report this year, but merely called attention to the new act. The Commission seems disposed to regard favorably the established standards of the Master Car Builders' Association and already some conferences have been had looking toward the promulgation of proper rules, but until the Commission issues those rules it is thought that the Association had better refrain from attempting any further change in its own rules.

### Committee Reports.

Unless otherwise stated the reports of the committees noted below were accepted by the convention and referred to letter ballot for final approval.

RULES FOR LOADING LONG MATERIALS.—Several minor changes were reported in these rules and they were all accepted with the exception of Rule 15-C, which provided "For loads on top of sides of gondola cars the distance from top of rail to center of load, measured at bearing pieces, must not exceed 9 ft. 3 ins.," and Rule 26, which substituted metal for wood spacing blocks between two or more cars carrying a unit piece. In times of car shortage it is often necessary to use gondola cars for long and high loading, and it was the intention of the new Rule 15-C to keep the center of gravity down on such loading, but it was brought out that the number of accidents with high loading on such cars has been practically nil, so the convention struck out the rule. A number of members favored the metal spacing block, but a majority was opposed to its enforced use. A wooden block with angle iron corner stiffeners is being used with great success.

COUPLER AND DRAFT EQUIPMENT.—Some suggestions on changes in this matter were accepted, as was also a report on a proposed testing machine for friction draft gears. This machine will be set up during the coming year and tests made. Last year the committee reported that a testing machine for friction draft gears should be dynamic, so as to approximate service conditions, and to reach this result, the machine as designed consists of two pendulums, each weighing 105 tons, which are allowed to drop simultaneously against the opposite ends of a gear. The machine is equipped with recording devices for comparative study.

TRAIN PIPE AND CONNECTIONS FOR STEAM HEAT.—The committee this year reported on some tests on a comparison between the large hose and couplings and medium hose and couplings, as follows:

> From the data obtained we find, of course, that the large coupling will allow steam to pass more freely than the medium, but the difference is not so great as to be of much consequence. We believe that either large or medium is entirely satisfactory. Many railroads have large equipment on their passenger cars and passenger locomotives. On the other hand there are many prominent railroads using the medium equipment, which is doing good work. From this you will note the investment in large and medium couplers is of considerable magnitude, and, fortunately, the location of the roads using the large coupler is such that their passenger equipment seldom interchanges with the roads using the medium coupler; therefore, no difficulty whatever, so far as we can see, will ensue if the roads now using the large coupler continue to use the large coupler and the roads now using the medium coupler continue to use the medium coupler. It would certainly be asking a great deal of either the users of the large or medium couplers to change, and for this reason your committee would not recommend either for standard of this Association.

CLASSES OF CARS.—Acting on the request of the American Railway Association, the committee presented a report in which were given the definitions of all classes of cars in railway use and their designating letters. This clears up some complications as to exact definitions of cars.

SALT-WATER DRIPPINGS.—In accordance with instructions from last year's convention, a design was submitted of a tank attachment to refrigerator cars, whereby the saline drippings detrimental to track and structure are held to be emptied at proper stations.

TRAIN BRAKE AND SIGNAL EQUIPMENT.—During the past year extensive experiments have been carried out by the Lake Shore & Michigan Southern Ry., upon emergency braking of heavy passenger trains at high speed. As a result of the tests, a voluminous report was presented by the committee, embodying recommendations for equipment for brakes on high-speed, heavy passenger trains.

BRAKE-SHOE TESTS.—As a result of tests made at the Association's laboratory at Purdue University, the Committee makes some important recommendations. In brief, these are as follows: Shoes when tested upon a cast-iron wheel, in effecting stops from an initial speed of 40 mi. per hr., shall develop a mean coefficient of friction of not less than 22% when the brake-shoe pressure is 2,808 lbs. and 16% when it is 6,840 lbs. For steel-tired wheels these percentages are 12½% under 6,840 lbs. pressure and 11% under 12,000 lbs. pressure. From the test the committee concludes that

> none of the ordinary shoes in service are likely to cause any appreciable wear on the cast-iron wheel. The wear on the steel wheel, while greater than on the cast-iron wheel, is likewise almost inconsiderable. After consideration of all the facts here presented, the committee has concluded that no serious wear of the wheel is to be expected from the action of any of the shoes now in ordinary service.

In regard to shoe-wear it was observed that

> (1) The shoes tested present great variation in their wearing qualities, the ratio between the poorest and the best shoe being as great as 1 to 6; (2) the relative resistance to wear exhibited by different shoes is somewhat affected by the severity of the application. Of a series of shoes, the one which suffers least from wear at light pressures may not be the one which suffers least under a heavy pressure; (3) all shoes tested wear more rapidly on a steel-tired wheel than on a cast-iron wheel, when tested under like pressures; (4) in general terms, it may be stated that the shoes which show a wear greatly below the average are those which cause wear in the wheel; (5) all shoes show greater wear, per unit of work performed, when applied under the higher pressure. The ratio is occasionally as great as 1 to 10.

LUMBER SPECIFICATIONS.—In cooperation with committees from the American Railway Master Mechanics' Association, the Railway Storekeepers' Association and various lumber manufacturers' associations, this committee submitted "Lumber Specifications" which, with some minor recommended changes were accepted and passed to letter ballot. It is intended to use these specifications in all lumber purchases.

VARIOUS COMMITTEES.—The standing committee on "Car Wheels" submitted a report in which the main point of interest was the design of measuring gages and tapes. The Committee on "Splicing Underframing" made some minor recommendations that were accepted and also suggested that the scarf splice for splicing longitudinal sills (shown in the report of tests last year to be very weak compared to the butt splice) be considered improper repairs, but the recommendation was not sent to letter ballot. Instead it was sent to the Arbitration Committee for report. The Tank Car requirements, which for years have been recommended practice, were sent to letter ballot to be made standard. The Committee on "Train Lighting" submitted some detailed designs and recommendations; the report was accepted but not sent to letter ballot.

Mr. E. D. Nelson, Engineer of Tests of the Pennsylvania R. R., submitted, in an individual paper the design of an axle to carry 50,000 lbs., a larger axle than any standard of the Association. In view of the increasing weight of cars it was recomended by a member that committees be appointed to design standard trucks to carry this increased weight car. This was referred to the Executive Committee for action. Mr. Nelson's design was sent to letter ballot as recommended practice.

### Officers.

According to the new constitution, the voting this year was by secret written ballot, and each officer was elected from among a number of nominees, instead of the single-name nomination common in most technical societies. The officers elected were as follows: President, T. H. Curtis, Sup't of Machinery, L. & N. R. R.; Vice-Presidents, A. Stewart, Genl. Supt. Motive Power, Southern Ry., C. E. Fuller, Supt. Motive Power, U. P. R. R., D. F. Crawford, Genl. Supt. Motive Power, Penna. Lines West; and Treasurer, John S. Lentz, Master Car Builder, L. V. R. R. Mr. John Kirby, who has been Treasurer of the Association for some years, and who is now in his 87th year, presented his resignation which was accepted with a rising vote of thanks and appreciation. Mr. Kirby was one of the founders of the Association and was President from 1891 to 1893. Mr. Jos. W. Taylor is Secretary of the Association and his address is 300 Old Colony Bldg., Chicago, Ill.

## Notes from Engineering Schools.

McGILL UNIVERSITY.—Announcement has been made that the Grand Trunk Ry. will maintain three free scholarships, covering four-year courses in the school of applied science. These scholarships are available to apprentices and to other employees of the railway, under 21 years of age, and to minor sons of employees. Grants will be for one year, to be periodically renewed if the holder makes satisfactory progress. The scholarships will be awarded after competitive examinations and holders will be required to serve the road as apprentices during the vacations and, at the option of the company, after completion of the course. Conditions of admission may be obtained from the Registrar of McGill University, Montreal, P. Q.

A similar plan was made possible in 1907, for the Pennsylvania Railroad employees by children of the late Frank Thomson, once president of the company. There are eight scholarships, amounting to $600 a year each, designed to give sons of living and deceased employees of the railroad an opportunity for such a technical education as would better enable them to qualify themselves for employment by the company. Each year since the establishment of the fund two scholarships have been awarded and the full number (eight) will be maintained in succeeding years. Three of the present six holders are students in the University of Pennsylvania, one is at the University of Michigan, one at Yale and one at Harvard. Competitive examinations for the two unawarded will be held during the latter part of this month by the College Entrance Examination Board of New York City which will act for the Pennsylvania R. R. Co. The examinations correspond in general to the entrance requirements of the best technical schools. They are open to the sons of some 200,000 men, that is, to the sons of all employees, living or deceased, of all the Pennsylvania lines, east and west of Pittsburg.

LEHIGH UNIVERSITY.—The dedication exercises of the John Fritz Engineering Laboratory and of the Eckley B. Coxe Mining Laboratory were held June 11. Addresses were made by Mr. R. W. Hunt, M. Am. Soc. C. E., M. Am. Inst. M. E., of Chicago, President H. S. Drinker and Mr. T. C. Martin, M. Am. Inst. C. E., of New York City.

The Engineering Laboratory was given by Mr. Fritz in order that Lehigh University might have a fine testing laboratory. The building was designed by Mr. Fritz and the erection and equipment were under his personal supervision. The building is of steel-frame construction, 115 ft. long and 94 ft. wide. The main (central) section is 65 ft. high and the two side sections are

somewhat less. The exterior walls are of cement-brick and are lined with red brick. A ten-ton electric traveling crane is installed in the main section to handle large test specimens. An 800,000-lb. Riehle vertical-screw machine is to be used for 25-ft. columns or for tensile tests of specimens up to 20 ft. long. Transverse tests can be made on 30-ft. specimens. There will be an Olsen 300,000-lb. universal machine and smaller apparatus for ordinary tests. It is proposed to operate a complete road-material testing plant. There will be a small machine shop in this building and also a hydraulic laboratory and a section for making and storing concrete.

The Eckley B. Coxe Mining Laboratory is a dressed sandstone building, 100 ft. long by 75 ft. deep and one story high in front with a raised floor at the rear. The main section contains the ore-dressing laboratory, 40 × 70 ft., leaving the west wing for a chemical laboratory, assaying room and shop. The east wing contains an office and recitation room, on the main floor, and locker and wash rooms in the basement. The ore-dressing machinery will be driven by five separate motors so that part or all can be driven as desired.

FLOODS THROUGHOUT HUNGARY early in June caused extensive damage to crops and property and a loss of life estimated in press reports at about 1,000.

A VIOLENT WIND AND RAIN STORM visited New York City June 18 felling a large number of shade trees in streets and parks and wrecking many small boats along the Long Island beaches. Fatalities to the number of 17 have been reported.

On the same date, severe storms and resulting freshets in western Pennsylvania did heavy damage to buildings and crops. The Baltimore & Ohio R. R., Western Maryland R. R. and others suffered from washouts and damage to bridges in Pennsylvania and Maryland.

A POWDER MILL EXPLOSION near Coudertsport, Pa., June 14, destroyed the Buck Powder Works and killed Clarence Buck, the inventor of the "safety" powder manufactured, and his son. The explosion originated in the mixing room.

A LODGING HOUSE FIRE June 15 at Niagara Falls, Canada, caused the deaths of twelve laborers employed by the Ontario Power Co. and the injury of eight others. The fire broke out at 1 a. m. when all the men were asleep. The building was entirely destroyed.

AN EXPLOSION OF GASOLINE in a sewer in West 50th St., New York City, on June 20, threw nine iron manhole covers high into the air. No one was injured though it is reported that many women on a Hudson River recreation pier at the foot of the street were badly frightened as one cover went soaring over them. The explosion is very similar to one discussed in Engineering News Dec. 2, 1909. The gasoline was then found to come from the automobile garages which are numerous in this section of the city.

A FRENCH EXPRESS TRAIN collided with the rear of a local train which was standing at the station at Villepreux, France, June 18. The wreck was followed by a fire. Nineteen persons were killed and 30 injured.

A BUTTING COLLISION between a light engine and a passenger train loaded with immigrants took place on the New York, Ontario & Western Railway at Parker, N. Y., 16 miles southeast of Norwich, June 19. The forward coach was crushed against the tender of its locomotive while the seven following coaches were not much damaged. Three passengers were killed and 20 injured, all in the one car which was wrecked. The accident is ascribed to disregard of orders on the part of the light locomotive's engineer.

THE 93 MILES OF TRACK WASHED OUT in January, 1910, on the line of the San Pedro, Los Angeles & Salt Lake R. R., through eastern Nevada have been temporarily rebuilt over the same route along the Meadow Valley Wash. Passenger traffic was resumed over this temporary line June 15. Meanwhile work is being pushed on the construction of a permanent parallel line following a route less subject to floods. A brief note of the washout was published in our issue of Jan. 20, 1910, p. 82.

A NEW HEIGHT RECORD for aeroplanes was made by W. H. Brookins at Indianapolis when he reached a point 4,503 ft. above the ground, using a Wright biplane. The only feature of novelty was a long glide to earth after his engine gave out.

APPLICATIONS FOR TWO PROFESSORSHIPS in the Technical High School of Trondhjem, Norway, are wanted prior to July 31, as announced in detail in our advertising columns. One is a professorship of mechanical technology and machine tools; the other, of naval architecture, not including machinery. The salaries offered in each case are about $1,130 per year, with successive increases of about $125 per year at the end of 5, 10 and 15 years. The advertisement states that

> If an applicant requires one or more of the additional sums from the first and such demand appears sufficiently warranted, the Government might apply to the Storting for the increase.

THE WIDENING OF 42D ST., NEW YORK CITY, between Park and Eighth Aves., has been decided upon by the Board of Estimate and Apportionment. On favorable report of Mr. N. P. Lewis, M. Am. Soc. C. E., Chief Engineer, a total increase of 15 ft. from curb to curb is to be secured by reducing the width of each sidewalk 7½ ft. A reduction in sidewalk width will in part be compensated for by the removal of building encroachments. It is reported that the cost, which is estimated at $500,000, will be borne by the property owners.

OZONIZED AIR is now used as an adjunct to ventilation in the Chicago Public Library. It is claimed that the use of ozonized air has completely freed the reading room from the obnoxious human odor which has been remarked upon for years.

The air to be passed through the ozonizer is washed. This ozone generator, consisting of cylindrical brushes separated by glass plates, is about 6 ft. high, 11 ins. thick and 12 ins. wide and is installed in a large air duct in such a way that all the air is forced between the electrodes, across which a potential of 7,000 volts is maintained. The energy required for treating the air is stated to be 660 watt-hrs. for 10,000 cu. ft. of air. The plant noted was installed by the National Air Filter Co., of Chicago.

AN AUCTION SALE OF THE GOVERNMENT CEment plant, build to make cement for the Roosevelt Dam, Ariz., is announced for the near future by the U. S. Reclamation Service. After turning out 337,000 bbls. of cement, the mill was shut down on completion of the dam not long ago. Prior to the decision to construct the mill, the U. S. Reclamation Service received informal bids of $9 per bbl. and $4.89 per bbl. for supplying cement for the dam. The actual cost of the cement turned out by the mill, including entire cost of construction and maintenance of the plant throughout, was $2.90 per bbl., thus showing a saving of about $675,000 for the Government. The Reclamation Service states that the demand for cement in the vicinity of the mill is increasing, and suggests that a plant of this

REFERENCE TABLE FOR FIGS. 2 AND 3 ON PP. 718 AND 719; SEATTLE FIREBOAT "DUWAMISH."

| Mark. | Inside diameter of pipe, ins. | Thickness. B.W.G. | Description. | Material. |
|---|---|---|---|---|
| 1 | 5 | 6 | Main steam from boilers | Copper |
| 2 | 8 | 2 | Main steam line | " |
| 3 | 10 | 1/0 | Main steam line | " |
| 4 | 7 | 4 | Main steam line | " |
| 5 | 5 | 6 | Main steam to propeller engines | " |
| 6 | 5 | 6 | Main steam to fire pumps | " |
| 7 | 3 | 9 | Auxiliary steam from boilers | " |
| 8 | 4 | 8 | Auxiliary steam to reducing valve | " |
| 9 | 4 | 11 | Auxiliary steam from reducing valve | " |
| 10 | 3 | 12 | Auxiliary steam line | " |
| 11 | 2½ | 13 | Auxiliary steam line | " |
| 12 | 3 | 9 | Main steam to auxiliary steam line | " |
| 13 | ¾ | .. | Steam to port sea valve | Iron |
| 14 | 2 | 13 | Steam to feed pumps | Copper |
| 15 | 1½ | 14 | Steam to F. W. pump and steering engine | " |
| 16 | ½ | 15 | Steam to fresh-water pump | " |
| 17 | 1¼ | 14 | Steam to steering engine | " |
| 19 | 1¼ | 14 | Steam to reversing engine and throttling valves | " |
| 20 | ¾ | 15 | Steam to throttle valve (by pass) | " |
| 21 | 2 | 13 | Steam to air pump | " |
| 22 | 1¼ | 14 | Steam to bilge pump | " |
| 23 | ¾ | .. | Steam to starboard sea valve | Iron |
| 24 | 1½ | 14 | Steam to electric generator | Copper |
| 25 | 2 | 13 | Steam to circulating pump | " |
| 26 | 1 | 14 | Steam to sanitary pump, etc | " |
| 27 | ¾ | .. | Steam to 14-in. sea valve | Iron |
| 28 | ½ | 15 | Steam to heating aft | Copper |
| 29 | ½ | 15 | Steam to sanitary pump | " |
| 31 | 2 | 13 | Reduced steam to oil pumps, capstan | " |
| 32 | .. | .. | Steam to whistle and siren | " |
| 33 | .. | .. | Steam to burners | " |
| 34 | 1¼ | 12 | Steam to injector | " |
| 36 | 2¼ | 8 | Main feeds to boilers | " |
| 37 | 2 | 8 | Auxiliary feeds to boilers | " |
| 38 | 1 | 12 | Boiler surface blows | " |
| 39 | 2 | 8 | Boiler bottom blows | " |
| 40 | 2½ | 8 | Blow-off connection to sea cock | " |
| 41 | 2 | 10 | Suction from boilers | " |
| 42 | 3 | 9 | Suction from boilers | " |
| 43 | 3¼ | 6 | Main feed line | " |
| 44 | 2¾ | 7 | Main feed line | " |
| 45 | 3¼ | 6 | Auxiliary feed line | " |
| 46 | 2½ | 6 | Auxiliary feed line | " |
| 47 | 1½ | 11 | Injector to auxiliary feed line | " |
| 48 | 3½ | 6 | Feed pump discharge to manifold | " |
| 49 | 12 | 11 | Main exhaust pipe | Copper |
| 50 | 10 | 12-14 | Main exhaust escape to atmosphere | " |
| 51 | 16 | 11 | Main exhaust to condenser | " |
| 52 | 8 | 11 | Exhaust from propeller engines | " |
| 53 | 7 | 12 | Exhaust from fire pumps | " |
| 54 | 6 | 14 | Escape pipes from safety valves | " |
| 55 | 5 | 14 | Outside escape from safety valves | " |
| 56 | 7 | 14 | Outside escape from safety valves | " |
| 57 | 5 | 12 | Auxiliary exhaust line | " |
| 58 | 6 | 12 | Auxiliary exhaust line | " |
| 59 | 6 | 12 | Auxiliary exhaust to atmosphere | " |
| 60 | 6 | 12 | Auxiliary exhaust to condenser | " |
| 61 | 3 | 14 | Exhaust from bilge and circulating pumps | " |
| 62 | 2½ | 15 | Exhaust from circulating pump | " |
| 63 | 1½ | 15 | Exhaust from bilge pump | " |
| 64 | 4½ | 13 | Exhaust from generator to condenser | " |
| 65 | 3 | 14 | Exhaust from generator to auxiliary line | " |
| 66 | 2½ | 15 | Exhaust from air pump | " |
| 67 | 1¼ | 15 | Exhaust from reversing engines | " |
| 68 | ¾ | 16 | Exhaust from sanitary pump | " |
| 69 | ¾ | 16 | Exhaust from fresh-water pump | " |
| 70 | 1 | 16 | Exhaust from sanitary and fresh-water pump | " |
| 71 | 1½ | 15 | Exhaust from steering engine | " |
| 72 | 2½ | 15 | Exhaust from feed pumps | " |
| 73 | 2 | 15 | Exhaust from oil pumps and capstan | " |
| 74 | 5 | 12 | Auxiliary exhaust to feed heater | " |
| 75 | 3 | 14 | Relief from heater to condenser | " |
| 76 | 2 | .. | Drain from condenser | Iron |
| 77 | 8 | 12 | Air pump suction from condenser | Copper |
| 78 | 7 | 12 | Air pump discharge to feed tank | " |
| 79 | 4 | 13 | Feed pump suction from condenser | " |
| 80 | 3 | 9 | Feed pump suction from boilers | " |
| 81 | 4 | 13 | Feed pump suction from sea | " |
| 82 | 4 | 13 | Feed pump suction from feed tank | " |
| 83 | 3½ | 13 | Feed pump discharge overboard | " |
| 84 | 14 | 12 | Circulating pump injection | " |
| 85 | 10 | 13 | Circulating bilge suction | " |
| 86 | 12 | 11 | Circulating discharge to condenser | " |
| 87 | 12 | 11 | Circulating discharge overboard | " |
| 88 | 2 | 14 | Sanitary pump sea suction | " |
| 89 | 1½ | 15 | Sanitary pump discharge to steam tank | " |
| 90 | 2 | 14 | Feed-water pump suction from fresh-water tank | " |
| 91 | 2 | .. | Suction pipe in fresh-water tank | " |
| 92 | 3 | .. | Suction pipe in fresh-water tank | " |
| 93 | 3 | .. | Bilge pump suction from fresh-water tank | " |
| 94 | 3 | .. | Bilge pump suction from engine room | " |
| 95 | 3 | .. | Bilge pump suction from bilge forward | " |
| 96 | 3 | .. | Bilge pump suction from boiler room | " |
| 97 | 3 | 9 | Bilge pump suction from boilers | " |
| 98 | 3 | 13 | Bilge pump to suction manifold | " |
| 99 | 3 | 13 | Bile pump discharge overboard | " |
| 100 | 10 | .. | Emergency bilge suction | " |
| 101 | 1 | 15 | Auxiliary fresh water to condenser | " |
| 102 | 16 | 12 | Fire pump sea connections | " |
| 103 | 12 | .. | Fire pump emergency suction | Iron |
| 104 | 4 | .. | Feed pumps to suction manifold | Copper |
| 105 | 2 | .. | Injector suction from fresh-water tank | " |
| 106 | 2 | .. | Feed-water pump discharge to feed tank | " |
| 107 | 1½ | .. | Feed-water pump discharge to supply tank | " |

kind operating in or near Phoenix would prove to be a profitable enterprise. Rock suitable for cement making was found in the vicinity of the dam.

SIGNAL INSTRUCTION CARS have been fitted up by the Pennsylvania R. R. on its divisions between Philadelphia and Pittsburg, and similar cars will be put on the other divisions also. All train and engine men are to be instructed in block signals, interlocking signals, and all other train movement signals. Track charts showing tracks, switches, track-tanks, signals, stations, etc., are mounted in the cars on tables, covered with glass. Working model signals are also provided, to explain signal movements and indications. An examiner with an assistant is in charge of the car. It is intended to make the employees thoroughly familiar with signal matters on the line, with a view to promoting safety of operation.

DEWATERING ZINC AND LEAD TAILINGS by means of a revolving cylindrical screen is described by Mr. A. O. Ihlseng, M. Am. Inst. M. E., of Joplin, Mo., in "The Engineering and Mining Journal" of April 9, 1910. The screen is 36 ins. wide and 30 ins. in diameter with 1 mm. mesh. It is placed with its axis horizontal and at right angles to the jig shaft. The screen is close to the delivery end of the battery of jigs and is revolved at about 10 r. p. m. The tailings and water from the jig pass down a short chute onto the top of the revolving screen. The water and fines drop through into a pan, which projects into the screen from outside supports, and flow away through a trough to the settling tanks. The tailings are carried around on the screen and drop into a hopper comparatively dry.

Mr. Ihlseng's article goes on to describe a method of handling the dewatered tailings by a belt conveyor which he says is much more convenient and economical than the ordinary tailings elevator.

MUNICIPAL OWNERSHIP OF WATER-WORKS AT Omaha, Nebraska, seems likely to come in a short time after many years of agitation and delay. The final and definite step to that end, it appears, will follow logically the decision of the U. S. Supreme Court on May 31, settling the litigation which has been going on for years past over the purchase price for the works. A board of appraisers was appointed in 1903 to put a purchase valuation on the property of the Omaha Water Co. This board included Mr. John W. Alvord, M. Am. Soc. C. E., Chicago, Mr. George H. Benzenberg, M. Am. Soc. C. E., Milwaukee, for the company, and Prof. Daniel W. Mead, M. Am. Soc. C. E., Chicago, chosen by the other two appraisers. After considerable delay caused by litigation, Messrs. Benzenberg and Mead submitted a report valuing the property of the company at $6,263,295. Mr. Alvord did not concur in that report. The valuation named included works supplying South Omaha, Florence and Dundee, as well as Omaha itself. The Omaha Water Board, which was created in 1903 to take over the works and to look after the water interests of the city, pending the transfer, refused to accept the valuation fixed by the appraisers, upon the grounds that the valuation was excessive and improperly made in some of the more or less technical details. The first of the lower courts sustained the board in its rejection of the award, but the Appellate Court reversed the findings of the lower court, and this reversal has now been upheld by the U. S. Supreme Court. It is expected that the property of the company will be taken over by the Omaha Water Board as soon as various technicalities can be complied with.

THE USE OF HYPOCHLORITE IN THE NEW SWIMming pool of the Memorial Gymnasium, at Purdue University, was experimented with some months ago. A summary of the tests was given in a paper on the use of hypochlorite for water purification presented before the Indiana Sanitary and Water Supply Association, Indianapolis, Feb. 23, 1910, by Prof. Severance Burrage, of Purdue. We quote from the paper as follows:

This swimming pool contains 85,000 gals. of water and under ordinary conditions of use has been emptied, cleaned and refilled twice a week, at a total expense of from $16 to $20 per week. The writer's attention was called to the hygienic condition of the swimming pool on account of some epidemics of colds and sore throats which seemed to come from the use of the pool. Some bacteriological analyses of the water in the pool after it had been used gave numbers as high as 140,000 per c. c., while the number of bacteria in the water-supply taken from faucets in the same building showed between 500 to 1,000 bacteria per c. c. It was evident that the quality of this water was anything but sanitary, and I concluded to try the use of some chemical disinfectant and see what the results would be. After consultation with several water experts, I concluded to try the hypochlorite, and I ran a test covering over two weeks, the first without the use of any hypochlorite, the swimming pool being managed in the usual way, and the second week, using the hypochlorite and without having the pool emptied and cleansed. The results of this test are shown in the accompanying table. The amount of hypochlorite used in these tests was in proportion of 20 lbs. to a million gallons. This would give somewhat less than one part per million of available chlorine. The results of this test show very well the efficiency of the use of this material.

The total percentage of reduction of the numbers of bacteria gave 99.8%. The removal of the Bacillus Coli, which was always present in the water after the pool had been used by bathers, was complete in every case after the use of hypochlorite. The method of application of the hypochlorite to the water in the pool was very simple, the powder being thrown over the surface as evenly as possible by hand as one walked around the pool. The powder immediately sank to the bottom, dissolving on the way and, in this manner, I believe, all portions of the pool were reached without any stirring whatever. The bacteriological samples were collected near the surface (6 ins.) No chemical tests whatever were made from the water during the test.

As to the physical conditions of the water during the test, it is interesting to note that there were no visible effects whatever noticed by the bathers or by those who were conducting the experiment. On entering the pool room the morning after the application of the chlorine of lime, there was no odor whatever noticed. Before the pool was disturbed at all by the bathers, there could be detected a very slight scum on the surface of the pool, but I believe this was more, or at most very little more, than customarily collects there even without the use of the chemical. Those who used the pool during this week of the test knew nothing of the experiment that was going on and there were no complaints of any kind as far as the writer knows. The appearance of the water in general was the same as without the use of the hypochlorite.

From the standpoint of the hygiene of swimming pools, I regard this experiment as very suggestive. The application of the bleaching powder to the water in the pool is so easily made, the effect on the bathers is nil, the expense of its use is so slight that everything seems to point in its favor. From the nature of this experiment and from the reports of experiments on sewage and one or two water-supplies, where the hypochlorite is being used, the writer does not hesitate to prophesy that in the near future the hypochlorite will be very extensively used in the purification of suspicious and polluted waters.

THE FIXATION OF ATMOSPHERIC NITROGEN by a new and entirely novel process is announced by Prof. Fritz Haber and Dr. R. Le Rossignal, Karlsruhe Institute of Technology. The process, it is reported, has already passed from the merely laboratory stage and is being developed by the Badische Anilin und Soda Fabrik. The new process is the synthesis of ammonia ($NH_3$) from nitrogen and hydrogen under a pressure of 200 atmospheres and in the presence of a catalytic agent like osmium or uranium. High temperatures are avoided. The hydrogen is produced by any chemical process found desirable and the nitrogen is used as in the air. Details of the process are not available.

## Personals.

Mr. L. S. Griswold, M. Am. Inst. M. E., has resigned the chair of geology at the Missouri School of Mines for the purpose of giving his whole time to consulting work.

Mr. W. F. Schulz, an assistant engineer with the Louisville & Nashville R. R., has been appointed Resident Engineer in charge of construction of the Union Station at Memphis, Tenn.

Mr. Douglas L. McLean has been appointed Assistant to Chief Engineer M. H. Ramey, of the International Commission, St. Johns River, N. B., with headquarters at Van Buren, Me.

Mr. John P. Stanstrom, of Marshalltown, Iowa, has been promoted from foreman to Supervisor of Bridges and Buildings of the Fort Dodge Division of the Chicago Great Western Ry.

Mr. John F. Stevens, M. Am. Soc. C. E., has been made President of the Pacific & Eastern Ry., one of the Hill lines of Oregon. Mr. Stevens is now at the head of all the Hill railway projects in Oregon.

Mr. Francis H. Hambleton, M. Am. Soc. C. E., has resigned his position as Consulting Engineer of the Consolidated Gas, Electric Light & Power Co., of Baltimore, Md. He will continue in his position of director.

Mr. F. B. Maltby, M. Am. Soc. C. E., has resigned his position as Chief Engineer with Dodge & Day, Engineers of Philadelphia, Pa., and is now associated with James Stewart & Co., Contractors, 30 Church St., New York City.

Mr. E. J. Wright, formerly Assistant Division Superintendent of the Mohawk Electric Division of the New York Central Lines, has been made Assistant Superintendent of the Western Division, succeeding S. J. Kearns, promoted.

Mr. A. R. Ayers, formerly Division Master Mechanic of the Lake Shore & Michigan Southern Ry., has been made Mechanical Engineer of the Chicago, Indiana & Southern and of the Indiana Harbor Belt Rys., with headquarters at Cleveland, Ohio.

Mr. S. Whinery, M. Am. Soc. C. E., Consulting Engineer, New York City, has been retained by the Commission on City Expenditures of the city of Chicago to examine into the conditions and report upon improvements in the Street Department of that city.

Capt. A. H. P. Desborough, an imperial government expert at Woolwich Arsenal, England, has been engaged, with the consent of the Colonial Office, to advise the Department of Mines in regard to the proposed regulations for the manufacture, storage and use of explosives.

Mr. Joseph G. Hudson, a Mining Engineer of Ottawa, Ont., has been appointed by the Department of Mines of Canada to inspect and report on all the plants in Canada where explosives are manufactured or stored for the purpose of ascertaining what precautions are taken to insure the safety of workmen.

Mr. Thomas H. Ferguson has resigned his position as patent attorney for the Kellogg Switchboard & Supply Co. to open an office in the Marquette Bldg., Chicago, Ill. Mr. Ferguson is a graduate of the University of Michigan, class of 1896, and was for three years patent attorney for the General Electric Co.

## Obituary.

William Thomas Fitzpatrick, a civil engineer in the employ of the Board of Water Supply of New York City, died from scarlet fever at his home in Brooklyn on June 16.

D. Wheeler Swift, inventor of envelope machinery and a director of the United States Envelope Co., died at his home in Worcester, Mass., June 14. Mr. Swift was 70 years of age and had been a pioneer in the development of the envelope industry, being a member of the Logan, Swift & Brigham Envelope Co. at its formation.

Pete King, General Manager of the firm of Mason & Hanger, contractors, of Cornwall-on-Hudson, N. Y., died from tuberculosis at Loomis, N. Y., June 19, and was buried at Louisville, Ky., June 22. Mr. King had had charge of the construction of a great number of tunnels in the Southern and Western States. At the time of his death, the firm with which he was associated was engaged upon the construction of the Moodna syphon of New York City's water supply system.

## Engineering Societies.

COMING MEETINGS.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.
June 27-30. Annual convention at Jefferson, N. H. Secy., R. W. Pope, 33 West 39th St., New York City.

AMERICAN SOCIETY FOR TESTING MATERIALS.
June 28-July 2. Annual meeting at Atlantic City, N. J. Secy., Edgar Marburg, University of Pennsylvania, Philadelphia, Pa.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.
June 30-July 1. Semi-annual meeting at St. Louis, Mo. Secy., W. M. Mackay, P. O. Box 1818, New York City.

OHIO ELECTRIC LIGHT ASSOCIATION.
July 26-28. Annual convention at Cedar Point, Ohio. Secy., D. L. Gaskill, Greenville, Ohio.

TRAVELING ENGINEERS' ASSOCIATION.
Aug. 16-19. Annual convention at Niagara Falls, Canada. Secy., W. O. Thompson, New York Central Car Shops, East Buffalo, N. Y.

NATIONAL IRRIGATION CONGRESS.—The 18th congress will convene in Pueblo, Colo., Sept. 26. The president of the congress is Mr. B. A. Fowler, Phoenix, Ariz.

ILLUMINATING ENGINEERING SOCIETY.—The annual convention of this society will be held in Baltimore, Md., beginning Oct. 24. The date had been previously announced as the latter part of August.

ARIZONA ASSOCIATION OF ENGINEERS.—At a meeting of the civil engineers of Phoenix, Ariz., it was decided to revive this association enlarging its scope so as to include in its membership not only civil, but mining, mechanical and electrical engineers and architects.

THE AMERICAN IRON AND STEEL INSTITUTE.—The first regular meeting of this society, which was organized in 1908, was held at New York City on May 27. The subjects discussed at the dinner were international competition and some phases of the labor question. The following officers were elected: President, E. H. Gary; Secretary, W. J. Filbert, 71 Broadway, New York City.

AMERICAN SOCIETY OF CIVIL ENGINEERS.—The San Francisco association held its regular bi-monthly meeting at the Palace Hotel, June 17. The program included the presentation of a paper by Morton L. Tower on the "Results Obtained by the Coos Bay, Ore., Jetty," and the discussion of the papers "Pressure Resistance and Stability of Earth," by J. C. Meem; "Reinforced-Concrete Pier Construction," by Eugene Klapp; "Remedies for Land Slides and Slips on the Kanawha and Michigan Railway," by R. P. Black, and "The Ultimate Load on Pile Foundations: a Static Theory," by John H. Griffith.

THE FARADAY SOCIETY.—The 51st ordinary meeting of the society was held in London, May 31. Papers were read on "Some Practical Experience of the Sherardizing Process," by Mr. J. W. Hinchley, and on "Note on the Composition of Eutelic Mixtures," by Dr. Cecil H. Desch. Mr. C. V. Biggs and Mr. W. P. Digby exhibited and gave a short demonstration of an apparatus for the rapid determination of the electrical resistance of liquids and of an apparatus for the determination of the specific resistance of oil.

The secretary is Mr. F. S. Spiers, 82 Victoria St., London, S. W.